UPHOLSTERED FURNITURE FLAMMABILITY:

REGULATORY OPTIONS FOR SMALL OPEN FLAME & SMOKING MATERIAL IGNITED FIRES

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Executive Summary

The Consumer Product Safety Commission (CPSC) staff has prepared a briefing package describing the agency's recent activities and options for addressing flammability hazards associated with upholstered furniture. Based on the available information, the staff recommends that the Commission **defer action** for five months with respect to the risk of fires caused by small open flame ignitions of upholstered furniture, pending additional study of possible chronic health effects associated with certain fire retardant (FR) treatments that may be used to meet a performance standard. Since action to address the small open flame risk may also significantly affect the cigarette ignition risk, the staff further recommends that the Commission **defer action** on the outstanding portion of Petition FP 93-1, submitted by the National Association of State Fire Marshals (NASFM), to develop a flammability standard addressing the risk of fires caused by cigarette ignition of upholstered furniture, pending a Commission decision on the small open flame issue.

CPSC granted the NASFM petition in part and published an advance notice of proposed rulemaking (ANPR) in the Federal Register on June 15, 1994, announcing the agency's intention to develop a possible proposed small open flame rule. The Commission determined that small open flame fires (ignited by sources such as lighters, matches and candles) may pose an unreasonable risk to the public. The Commission denied that part of the petition requesting action on large open flame fires.

CPSC deferred action on the NASFM request regarding the cigarette ignition risk pending an evaluation of the cigarette ignition resistance of currently manufactured upholstered furniture, and the level of conformance to existing voluntary guidelines established by an industry group, the Upholstered Furniture Action Council (UFAC).

The staff conducted a number of technical studies to develop information needed to evaluate options to reduce the small open flame hazard and to evaluate the cigarette ignition hazard. The staff analyzed fire hazard data, including data from in-depth fire investigations; performed laboratory tests on furniture and component materials to establish their small open flame and cigarette ignition performance; developed a draft small open flame standard; studied possible health effects associated with potential exposure to FR chemical treatments; analyzed economic impacts of a possible standard and alternatives; analyzed public comments received in response to the ANPR; and monitored voluntary and international standards activities. Significant findings from these studies are summarized below.

Small Open Flame Ignition

- The numbers of deaths and injuries from open flame ignited upholstered furniture fires remained relatively constant since 1980. Since 1990, small open flame ignitions caused an estimated annual average of 100 deaths, 460 injuries, and about $50 million in property damage; this represents about 80% of annual average total open flame upholstered furniture fire losses. Even after adjusting for projected benefits of the CPSC's lighter rule, small open flame ignited furniture fires cost society an estimated $470 million per year.

- No national voluntary or mandatory standard addresses the small open flame ignition risk. CPSC laboratory tests show that most upholstered furniture sold in the U.S. does not resist ignition when exposed to typical small open flame sources like matches or lighters; testing also shows that the cover fabric is the furniture component that most heavily influences the ignition behavior of the product.

- Flame retardant technology is available--and currently used in the U.K.--to meet a small open flame performance standard. FR treated fabrics or barrier materials may reduce fire losses from both small open flame and cigarette ignitions. A small number of untreated upholstery cover materials, including leather, wool, and certain thermoplastics may also provide adequate performance.

- The annual cost to consumers of a small open flame standard like the one developed by the CPSC staff may be $460-720 million; however, a standard may substantially reduce both small open flame and cigarette ignited fire losses, and may have estimated annual net benefits to consumers (i.e., after subtracting estimated average costs) of about $300 million.

Cigarette Ignition

- The numbers of deaths and injuries from smoking material ignited upholstered furniture fires declined substantially since 1980. Several factors may explain the decline, including reduced smoking, increased smoke detector use, and the increased prevalence of ignition resistant materials, a trend influenced by the UFAC voluntary program. Still, in 1994, smoking material ignited furniture fires caused an estimated 410 deaths, 960 injuries, and $108 million in property loss, for total societal costs of $2.3 billion.

- Based on CPSC laboratory tests and manufacturers survey data, about 83% of currently manufactured furniture could be expected to resist cigarette ignition. Under another test approach favored by industry, about 92% of cigarettes placed on currently made furniture would not be expected to ignite.

- o CPSC's test results support the industry claim that about 90% of the dollar value of currently manufactured furniture conforms to UFAC's component test criteria; however, UFAC conformance does not necessarily assure ignition resistance of the assembled article of furniture.

- o The UFAC program encourages the use of cigarette ignition resistant materials and constructions, but allows the use of cigarette-ignitable upholstery materials, including certain heavyweight cottons and other predominantly cellulosic fabrics, with smolder-resistant barriers.

- o The potential benefits of eliminating cigarette ignited fires (by either eliminating or FR treating the relatively small percentage of current fabrics prone to cigarette ignition) could be large--ultimately approaching $1.7 billion per year for a very effective remedy. The use of FR upholstery materials to reduce cigarette ignitability would also improve small open flame performance.

Conclusions and Recommendations

A small open flame performance standard for upholstered furniture could effectively address the risk of fire related death, injury and property loss to the public. The staff's analysis indicates that such a standard is feasible and may have substantial net benefits to consumers as a result of reductions in both small open flame and cigarette ignited fire losses. Benefits from reduced cigarette ignited fire losses would accrue at no additional cost to consumers, and without imposing cigarette ignition requirements on industry.

The staff continues to encourage industry to develop a voluntary small open flame standard. The draft standard developed by the staff and included in this briefing package may serve as a basis for voluntary action. The staff plans to continue to gather and analyze data on promising approaches to reducing both small open flame and cigarette ignition.

The staff recommends that, prior to considering a proposed small open flame standard, the agency gather additional information on the potential consumer exposure to and possible chronic toxicity of FR chemicals that may be used to meet a standard. The staff recommends a CPSC-sponsored technical workshop as part of the effort to gather this additional information; the staff will report back to the Commission within five months of the Commission's decision.

A small open flame standard may affect the risk of cigarette ignited fires as well. Thus, the staff recommends that the Commission defer action on the cigarette ignition portion of the NASFM petition pending a decision on the small open flame issue.

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United States
CONSUMER PRODUCT SAFETY COMMISSION
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MEMORANDUM

DATE: OCT 24 1997

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SUBJECT: Upholstered Furniture Flammability: Fires Ignited by Small Open Flames and Cigarettes

This briefing package presents information and options for addressing the risk of upholstered furniture fires ignited by a) small open flame sources, such as lighters, matches and candles, and b) smoking materials, chiefly cigarettes. In 1994, the Consumer Product Safety Commission (CPSC) initiated a regulatory proceeding to address the small open flame ignition hazard. The Commission also directed the staff to develop information on cigarette ignition resistance and industry conformance to existing voluntary guidelines.

I. Introduction

In 1993, the National Association of State Fire Marshals (NASFM) petitioned the Commission to initiate a proceeding to develop a product safety standard addressing risks of death and injury from upholstered furniture fires (Petition FP 93-1). The petition and follow-up correspondence appear at Tab A. The petitioner suggested that CPSC adopt or issue a rule similar to existing specifications in effect in the state of California. These specifications are embodied in three Technical Bulletins issued by the California Bureau of Home Furnishings and Thermal Insulation (BHF):

- Technical Bulletin (TB)-116, a voluntary standard incorporating a full-scale test (i.e., of finished articles of upholstered furniture) for cigarette ignition resistance;
- TB-117, a mandatory standard for all upholstered furniture sold in California, incorporating component tests (of specified individual parts of upholstered furniture) for cigarette and small open flame ignition resistance; and

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- o TB-133, a mandatory standard for furniture intended for use in certain areas of public accommodation not protected by automatic sprinklers, incorporating full scale and composite (small scale mockup) tests for large open flame ignition performance.

CPSC announced receipt of the petition and solicited public comment in an August 8, 1993 Federal Register notice. Comments were received from a variety of interested parties, including industry groups, fire safety organizations, and others.

At a May 12, 1994 public meeting, based on available information, including information provided in the public comments, the Commission voted to grant the NASFM petition in part, with respect to the risk of small open flame ignited fires, and to initiate a proceeding under the Flammable Fabrics Act (FFA) to develop a possible small open flame standard. An advance notice of proposed rulemaking (ANPR), published in the June 15, 1994 Federal Register, appears at Tab A. The Commission denied the petition regarding large open flame ignited fires, and deferred action on the petition with respect to cigarette ignited fires pending a staff evaluation of:

- o the cigarette ignition resistance of currently manufactured upholstered furniture; and

- o the level of industry conformance to existing voluntary guidelines established by the Upholstered Furniture Action Council (UFAC).

This briefing package presents the results of the CPSC staff's work on small open flame ignition, and the staff's assessment of cigarette ignition resistance and UFAC conformance. Section II of the package briefly reviews the history of CPSC's involvement in addressing upholstered furniture fires. Section III updates the national fire data and describes the results of the staff's fire investigation study. Section IV summarizes the staff's technical work on small open flame hazard reduction activities, including a draft standard. Section V gives the staff's findings on cigarette ignitability and UFAC conformance. Sections VI and VII present options and recommendations for Commission consideration.

II. Background/History

CPSC has been concerned about upholstered furniture flammability since the agency's inception. The Commission's primary focus in the 1970's and 1980's was on smoldering ignitions from smoking materials (chiefly cigarettes), since these fires accounted for most of the observed fire losses.

In 1972, the Department of Commerce issued a Notice of Possible Need for a Standard for upholstered furniture under the Flammable Fabrics Act (FFA); in 1973, responsibility for administering the FFA was transferred to CPSC.

Under a CPSC contract, the National Bureau of Standards (NBS, now the National Institute of Standards & Technology, NIST) developed a draft standard in 1976. This draft standard contained upholstery fabric classifications and prescribed tests in which lit cigarettes were placed in various locations on a mockup (i.e., the composite of materials in a frame constructed to hold them in the test) representing the finished article of furniture. Full scale testing of finished articles of furniture was optional. Performance was measured by char length (a measure of sustained smoldering combustion) over time or by obvious ignition. This draft standard's test method was adopted by the National Fire Protection Association (NFPA) as NFPA 261 in 1983,and by ASTM, Inc. as ASTM E1352 in 1990.

In response to CPSC's activities in the 1970's, the industry formed UFAC, which established a Voluntary Action Program in 1978. This program included a fabric classification scheme, component tests, construction criteria and other requirements to promote the use of cigarette ignition resistant materials, primarily in upholstered furniture marketed for household use. Further improvements were incorporated over subsequent years: for example, provisions requiring heat-conducting welt cord were added in 1983; a test for decorative trim became effective in 1993. UFAC's procedures were published in NFPA 260 in 1986 and ASTM E1353 in 1990. Since the primary identified hazard involved cigarette fires, the program included no open flame provisions.

The advent of the UFAC program coincided with increasing production of upholstered furniture comprised of materials (e.g., thermoplastic fabrics) and constructions (e.g., polyurethane cushions and polyester fiberfill barriers) that tend to resist cigarette ignition. UFAC-sponsored tests of "pre-UFAC" furniture (made, for example, with readily ignitable cellulosic fabrics and untreated cotton batting) suggested that about 15% of such products would resist cigarette ignition. In 1980, CPSC full scale tests indicated the general level of cigarette ignition resistance among UFAC members' furniture was about 50%, based on the number of chairs resisting ignition.

CPSC deferred consideration of mandatory regulation in 1979 and again in 1981. The agency opted instead to work with industry to improve cigarette ignition resistance through the UFAC program. A goal of the program, agreed upon by CPSC and UFAC, was to achieve 80% ignition resistance among UFAC participants' upholstered furniture.

In 1977, the Commission received two petitions, from the California BHF (FP 77-2) and from the Olin Corporation (later docketed as FP 80-1), requesting TB-117-like performance requirements for polyurethane foam to address open flame ignited upholstered furniture fires. These petitions were denied for lack of supporting data in 1981. No actions were sought to incorporate open flame provisions in the UFAC program.

Between 1981 and 1985, CPSC sponsored a research project at NBS regarding open flame ignition characteristics of upholstered furniture. This work was incorporated into a larger NBS report, "Fire Behavior of Upholstered Furniture." The report has been widely referenced on issues such as ignition performance, test methodology and the relation of full scale to bench scale tests.

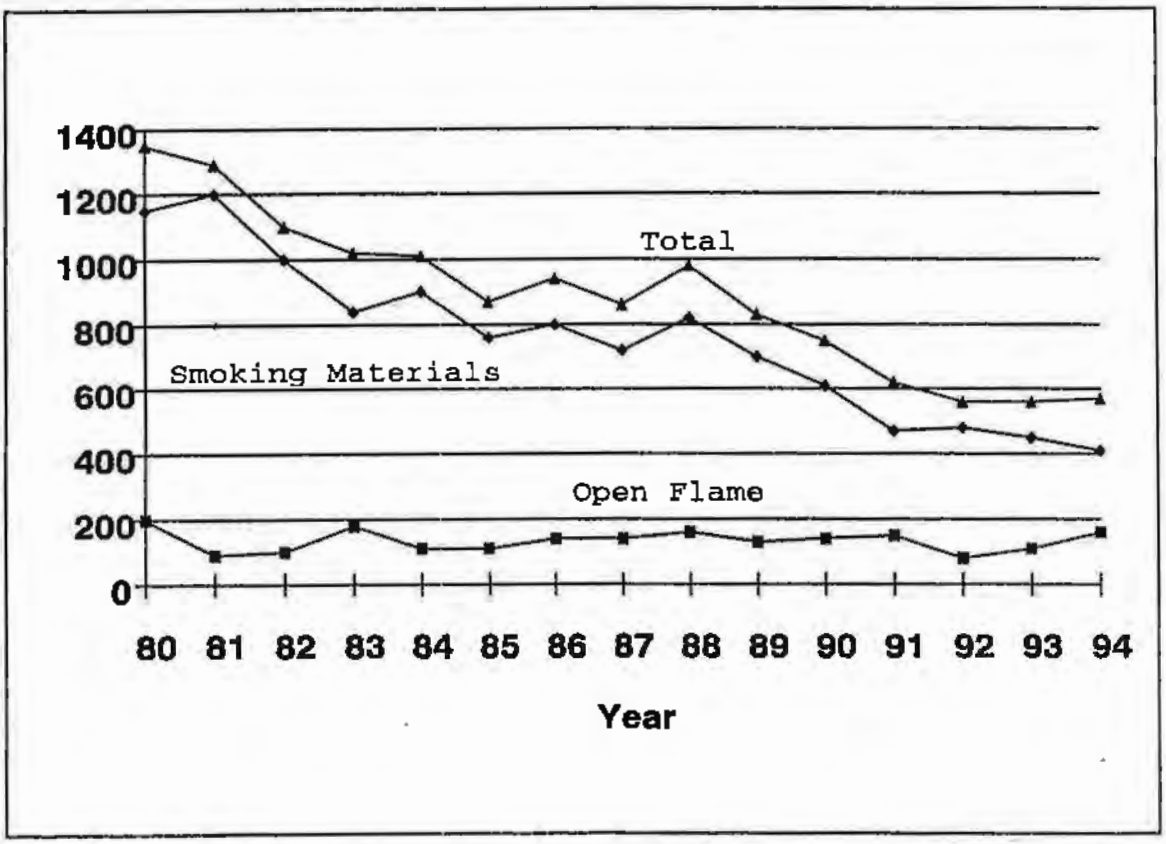
CPSC full scale tests in 1984 showed an improvement in the level of cigarette ignition resistance among tested products to about 68%. In 1985, UFAC reported that it had evaluated some flame retardant (FR) chemical treatments that might improve cigarette ignition resistance, but turned the evaluation over to chemical and textile companies for further investigation; no report or other action resulted from that investigation.

CPSC participated in voluntary activities on cigarette ignitions until 1986, when the Commission terminated work on the project. A final report on the project was issued in 1987. No change to the UFAC guidelines has been made since 1993, and none is currently planned.

III. Fire Hazard Data

Upholstered furniture fires continue to be the leading cause of residential fire deaths among products under the Commission's jurisdiction, accounting for nearly 20% of all civilian fire fatalities in 1994. Figure 1 presents national estimates of upholstered furniture fire deaths from smoking material and open flame ignitions for 1980-1994. Since the early 1980's, deaths and injuries from upholstered furniture fires declined substantially. Reduced losses from smoking material ignited fires accounted for most of the decline. The furniture fire data are discussed at Tab B.

Figure 1:
Estimated Upholstered Furniture Fire Deaths 1980-1994



Source: U.S. Consumer Product Safety Commission/EHHA, from data obtained from NFPA and U.S. Fire Administration.

A. Smoking Material Ignition

In 1994, an estimated 6,500 upholstered furniture fires ignited by smoking materials (98% of which involved cigarettes) caused 410 deaths, 960 injuries and about $108 million in property damage. The estimated societal cost of these fire losses is about $2.3 billion--roughly 60% of the nearly $4.0 billion total estimated upholstered furniture fire hazard costs.

Smoking material ignited fire deaths decreased by 64% from the 1980 level, or about 5% per year. A number of factors may have contributed to this observed decrease. The increased prevalence of non-cellulosic upholstery materials, which tend to be more cigarette ignition resistant, contributed significantly. The UFAC program encouraged the use of such cigarette ignition resistant materials. Other factors, such as decreased smoking, increased presence of smoke detectors, improved burn treatment, and improved fire safety education, also contributed. As newer, less cigarette ignition-prone furniture continues to replace older products in use, some further decrease in fire losses is expected, with smoking material ignited fire losses eventually leveling off.

Although estimated smoking material fires and deaths declined significantly since 1980, the risk of death and injury per fire has increased. The fire safety community and others have expressed concern that the increased use of plastics in upholstered furniture, particularly urethane foam and thermoplastic fabrics, may improve cigarette ignition resistance but worsen fire severity once ignition occurs.

B. Open Flame Ignition

For the most recent 5 years of fire data, an annual average of approximately 3,100 upholstered furniture fires ignited by small open flame sources--lighters, matches and candles--caused an average of 100 deaths, 460 injuries and nearly $50 million in property damage per year. The estimated annual societal cost of these fire losses is about $625 million. As Table 1 illustrates, small open flame sources were involved in about 77% of the average number of open flame related fatalities, 87% of injuries, and 80% of property damage during 1990-1994. In 1994 (the latest available data year), an estimated 3,800 open flame ignited upholstered furniture fires caused about 160 deaths, 540 injuries and $70 million in property damage.

Although the number of open flame ignited furniture fires declined significantly since 1980, there was no statistically significant change in the rate of death per fire, and there was a significant increase in the risk of injury per fire. As shown in Figure 1, the estimated number of deaths from open flame ignited furniture fires has remained relatively constant since 1980.

Table 1: Total Open Flame (O.F.) and Small Open Flame Ignited Upholstered Furniture Fire Losses 1990-94
(with % of total open flame losses attributable to small open flame fires)

	Deaths			Injuries			Property Damage ($mil)		
Year	Total O.F.	Small O.F.	% of total	Total O.F.	Small O.F.	% of total	Total O.F.	Small O.F.	% of total
1990	140	100	68%	530	470	89%	51	39	77%
1991	150	110	73%	580	490	84%	66	51	79%
1992	80	70	88%	490	450	92%	48	39	80%
1993	110	80	73%	490	400	82%	55	47	85%
1994	160	150	94%	540	470	87%	69	54	80%
Average	130	100	77%	530	460	87%	58	46	80%

Source: U.S. Consumer Product Safety Commission/EHHA, from data obtained from NFPA & U.S. Fire Administration.

C. Fire Investigation Study

The national fire loss estimates provide a basis for describing the overall open flame ignition problem and for identifying small flame sources involved in ignition. In 1994, to supplement the national data, the staff reviewed the approximately 100 existing CPSC records of in-depth investigations (IDI's) of open flame ignited furniture fires from the 1970's and 1980's. About half of these IDI's were small open flame related. A small number of cases yielded relevant information about ignition scenarios and mechanisms, suggesting that likely ignition locations on the furniture included skirts, dust covers (identified as the underside of the product) and seating area surfaces.

To obtain current information on a broader range of potential small open flame ignition sources, CPSC conducted a special study of in-depth investigations (IDI's) of current residential fires involving small open flame ignitions of upholstered furniture. Between October 1994 and February 1997, investigators from CPSC's Regional and Satellite Field Offices maintained weekly contact with cooperating local fire departments around the country, and investigated fire incidents determined to be within the scope of the study.

Of 201 reported cases screened for this study, 76 involved small open flame fires in which upholstered furniture was the first item ignited. The 76 cases included fires that caused 39 deaths and 45 injuries, as well as fires for which no casualties were reported. Cases involving cigarette ignitions or unknown ignition sources were excluded, as were open flame ignitions of pillows or blankets on furniture. Small open flame ignitions of paper or other materials used to ignite furniture were also excluded.

The investigations sought information on furniture characteristics, ignition locations, types of small flame sources, childplay involvement, fire loss experience, smoke detector presence and other household characteristics. The study conclusions are based on data from the 76 in-scope cases. A report on the methodology and findings of the small open flame fire IDI study appears at Tab B.

Highlights of the IDI study findings include the following:

- Of 38 cases reporting ignition locations, the seating area (cushion, inside arm, and inside back) was identified most often (25 cases) as the portion of the furniture first ignited; the outer back and side were identified in 9 cases; the area underneath (i.e., dust cover) was identified in 3 cases; and the skirt was identified in 1 case.

- Cigarette lighters were identified as the ignition source in 46 cases, matches in 14, and candles in 10; 3 more fires involved lighters or matches (although which of the two could not be ascertained).

- Childplay predominated (65 (86%) of the 76 cases) as the cause of the fires; 58 of the 65 childplay cases involved lighters or matches; 38 of these 58 were started by children under age 5; tipped candles lit by adults accounted for most of the remainder, with 8 cases.

- Of the 46 total known lighter fires, 44 involved childplay; 35 of these 44 were started by children under 5; 30 of the 44 childplay cases reported whether the lighter was a child resistant model; 9 of these 30 involved child resistant lighters; 7 of these 9 were used by children under 5 (whether the lighter's child resistant mechanism had been defeated could not be determined since samples were not available); 21 cases reportedly involved non-child resistant lighters.

The IDI study results generally indicate that childplay with lighters and matches, especially among children under 5, constitutes a major component of the open flame furniture fire problem. The study also provides more empirical evidence that furniture seating areas are the primary ignition location. Dust covers and skirts were less often identified than they were in the 1994 review of existing IDI's of incidents that occurred in the 1970's and 1980's.

The study was designed to include fires from a representative sample of upholstered furniture fires reported to fire departments. The staff notes that the investigated cases were limited in number and not from a national sample with known probability of selection. Nevertheless, the study provides important information about ignition circumstances.

IV. Small Open Flame Ignition: Regulatory Development

This section describes the staff's technical activities on small open flame ignition following publication of the 1994 ANPR. The efforts include laboratory testing, technical research and development and economic analysis. The staff also analyzed public comments and monitored voluntary and international standards activities.

A. Laboratory Testing

To gain a better understanding of small open flame ignition performance of upholstered furniture and to support the development of a possible standard, the staff conducted full scale tests on chairs. The staff also conducted smaller, bench scale tests on mockup assemblies and components of chairs. The resulting experimental data supplement research conducted by CPSC and others on small open flame performance and its relation to cigarette ignitability.

While the available information from previous technical work indicated a small open flame standard might be technically feasible, no reliable, comprehensive data existed to characterize the relative small open flame ignition behavior of different kinds of upholstered furniture products (i.e., full scale tests). Similarly, insufficient data existed to demonstrate the feasibility of a bench scale, small open flame test method that might be suitable for adoption in a possible voluntary or mandatory standard. CPSC's recent laboratory testing provides an experimental basis for a possible standard.

1. Full Scale Tests

In 1994 and 1995, the staff carried out a test program to evaluate the small open flame ignition resistance of finished items of furniture. Tests of 27 chairs were performed, using a CPSC staff-developed full scale test protocol. In addition, two existing small flame test methods--those in California TB-117 and the British standard BS 5852--were evaluated for predictability of full scale ignition behavior. A detailed report on this program appears at Tab C.

CPSC tested chairs supplied by 3 manufacturers, each manufacturer providing sets of 3 different styles of chairs manufactured for sale in a) California, b) the U.K., and c) the U.S. (non-California) market. All 27 chairs used popular, conventional (non-FR treated) upholstery fabrics. Each triplicate built to the 3 specifications used identical cover fabrics. The California chairs had FR foam fillings. The U.K. chairs had fire-blocking interliners between the cover fabric and

FR foam, as allowed under the U.K. regulations for products whose fabrics contain more than 75% of certain cellulosic fibers (most U.K. furniture is reportedly made with FR fabrics). The UFAC (non-California) chairs had conventional, untreated polyurethane foams, but were otherwise identical to the California chairs.

The staff first conducted experiments to determine the approximate continuous burn times of matches and lighters. Most match burn times in these experiments were in the 10-30 second range; lighter maximum continuous burn times ranged from 3-15 minutes. These experiments are described in a staff memorandum attached to the full scale test report at Tab C.

The full scale protocol used a butane burner similar to that in BS 5852. For a conservative test, in view of the observed range of lighter burn times, the test burner was applied for progressively increasing time intervals (5, 15, 20, 25 and 50 seconds) in 3 potential ignition locations: the seating area (the seat cushion junction with either the inside back or side); dust cover (the non-structural material on the underside of some furniture items); and skirt (the loose decorative layers of fabric around the bottoms of some items). Observations of ignition and post-ignition behavior were recorded for a 2 minute period, representing the critical early stages of combustion that determine whether the fire may spread to other combustible room furnishings and contents.

The upholstery materials in the seating areas and skirts of all 27 chairs ignited during testing, usually within 15 seconds. In seating area tests, filling materials underneath the upholstery fabrics became involved in the California and UFAC chairs; the U.K. chairs' interliners did not prevent ignition or cause self-extinguishment of cover fabrics, but did prevent interior materials from becoming involved.

Twenty-two dust covers ignited. Some nonwoven thermoplastic, inherently flame resistant materials did not sustain combustion (i.e., did not ignite), but melted away exposing flammable materials above. Other nonwoven dust covers did not ignite because they were attached to a wooden base that acted as a heat sink and prevented ignition.

After testing the finished chairs using the full scale protocol, the staff tested materials used in the test chairs in accordance with their respective California and British standard methods. The bench scale component test in TB-117 did not predict full scale ignitability: complying fabrics and fillings in California chairs charred and melted in full scale tests, and flames spread rapidly to the tops of the test chairs. The bench scale composite test in BS 5852 was predictive of fabric ignitions among the U.K. chairs: the U.K. mockups all failed the composite test, and the chairs all ignited in full scale testing.

The full scale test results demonstrated that the characteristics of upholstery cover materials are the primary determinants of open flame furniture ignitability. The tests also revealed that ignitions occurred consistently over a range of typical thermoplastic, cellulosic and blend fabrics of various constructions and weights. The full scale experimental findings, along with the experience the staff gained in designing and refining test procedures and apparatus, guided the development of a bench scale test, as discussed below.

2. Bench Scale Tests

Full scale flammability tests are costly, space- and time-consuming, destructive and occasionally dangerous; these drawbacks tend to make such tests impractical and unpopular with manufacturers and testing organizations. Bench scale tests can reasonably be substituted for full scale tests when the bench scale results can be shown to reflect known full scale outcomes.

The staff devised a bench scale test method for upholstered furniture based on the results of the full scale tests, available hazard data, recommendations from technical consultants and industry experts, and other information. This test method adopts the mockup approach of BS 5852 (and other existing international standards described in Section IV-E), and contains a number of provisions that are the same as those in the British standard.

The CPSC method contains performance tests for seating areas, dust covers and skirts. In the seating area test, a horizontal burner delivers a 35mm butane flame to the center of the seat/back crevice area of a metal frame mockup of upholstery cover and filling materials. In the dust cover test, the burner applies the flame vertically from underneath, the flame tip just touching the center of a horizontally suspended test specimen. In the skirt test, a vertical flame is similarly applied to the bottom edge of a vertically suspended specimen.

The staff designed and built an automated, electromechanical bench scale test apparatus to conduct the tests. The test fixture and apparatus are depicted in Figures 2 and 3. A summary of the staff's bench scale test program, along with detailed reports on each aspect of the bench scale laboratory testing, appears at Tab D.

Based on the full scale and bench scale testing, together with analyses of the predictive strengths and weaknesses of other existing tests, the staff considers the CPSC bench scale method to be a reasonable predictor of the small open flame performance of finished articles of upholstered furniture. The staff conducted extensive testing of furniture materials with the CPSC method to generate data on small open flame ignition resistance and post-ignition behavior. The staff also made some preliminary

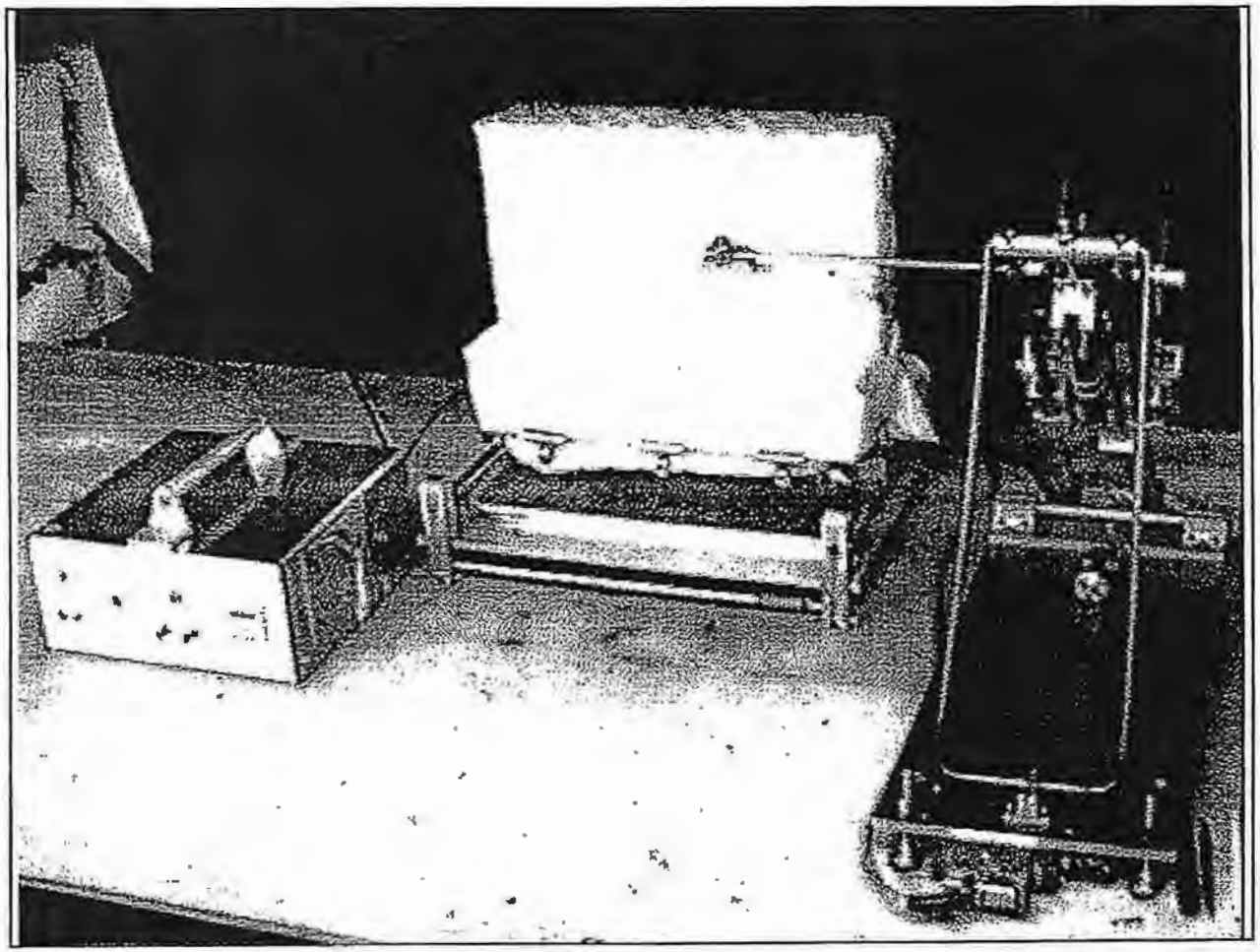


Figure 2:
Upholstered Furniture Seating Area Test Fixture & Mockup

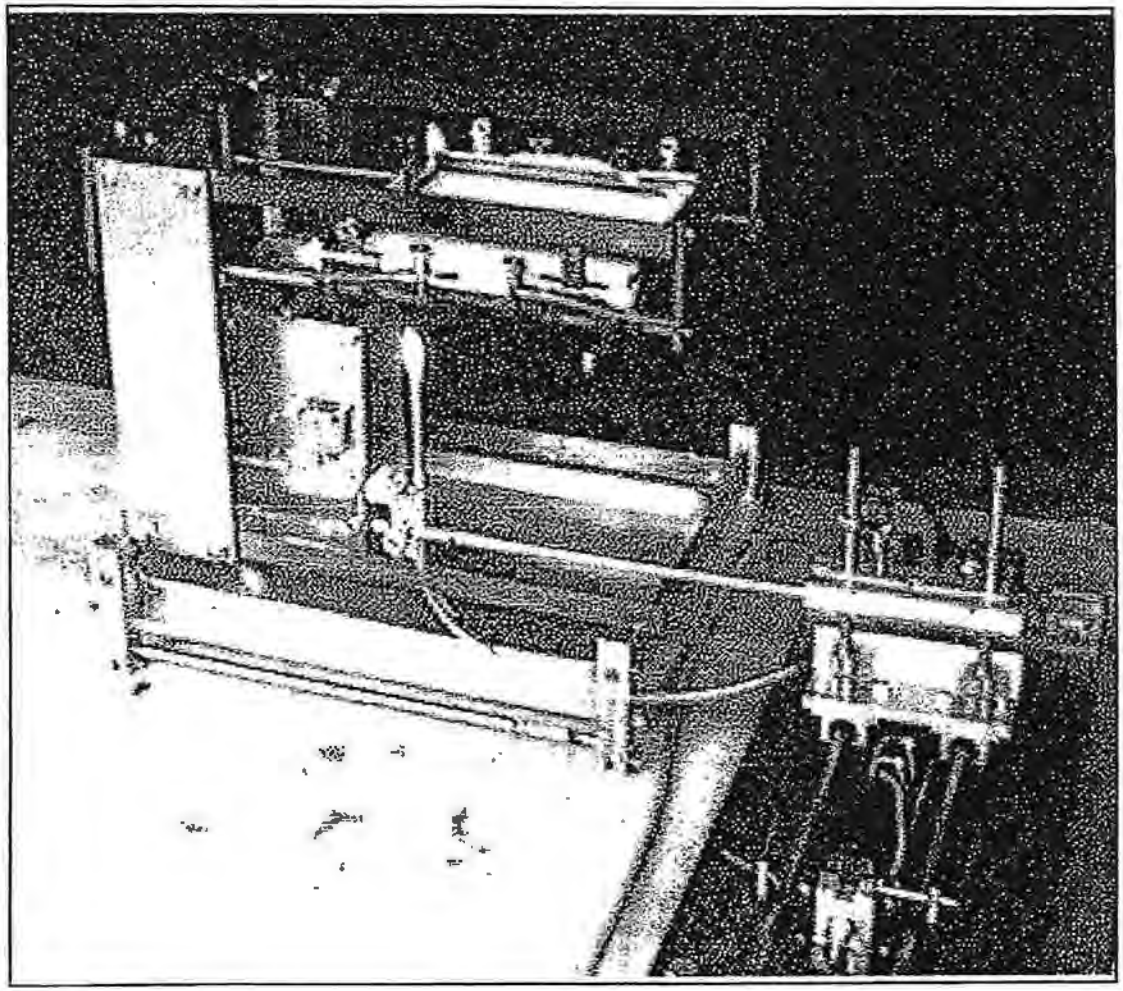


Figure 3:
Upholstered Furniture Dust Cover Test Fixture

observations, based on limited tests, about the potential of some promising approaches to improve small open flame ignition performance. The staff's evaluation of various fabrics and filling materials is discussed in the following subsections.

a) Fabrics. The staff evaluated the small open flame ignition resistance and post-ignition behavior of 74 different upholstery cover fabrics in seating area mockups. The fabrics represented a wide range of fiber contents, weights and constructions, and included some FR treated fabrics not currently used in U.S. residential market furniture. The mockups used conventional, untreated polyurethane foam fillings.

In tests with conventional, non-FR fabrics, all but one of the tested seating area mockups ignited in 30 seconds or less; most ignited in 15 seconds or less. Most ignited mockups continued to burn (i.e., would have been consumed by fire), but some self-extinguished, usually within a period of 2 minutes. Two heavyweight cellulosic fabrics took 19-20 seconds to ignite and also sometimes self-extinguished. Two other cellulosics and a wool fabric took between 20 and 30 seconds to ignite; one heavyweight cotton/rayon fabric did not ignite even at 30 seconds of flame exposure. Heavier fabrics (10 oz/yd^2 or more) generally took longer to ignite than lighter weight fabrics, and pile fabrics resisted ignition for somewhat longer than others. Leather and vinyl were not tested in the bench scale program, but are widely considered to be small open flame resistant.

The staff also tested 13 different FR fabrics, in most of which an FR chemical treatment mixture is contained in a separate polymeric coating fused to the reverse (interior) surface of the fabric. Two backcoated fabrics (one cellulosic/thermoplastic blend, one 100% thermoplastic) provided by U.S. fabric producers required 25-30 seconds of flame application to ignite, and sometimes self-extinguished within a few seconds.

The staff also obtained and tested FR fabrics from British suppliers. These fabrics are currently used in products sold in the U.K. Of the 11 British FR fabrics tested thus far, seven either did not ignite upon small open flame exposure of up to 20 seconds, or ignited but consistently self-extinguished in less than 2 minutes. One self-extinguished but not always within 2 minutes. One occasionally self-extinguished but sometimes continued to burn. The remaining two lightweight cellulosic fabrics ignited and continued to burn; however, chemical analysis showed a relatively low FR chemical content in these samples, suggesting that they may not have been adequately FR treated.

In addition to treated fabrics, the staff tested four intumescent, or "active" FR treated barrier fabrics provided by two manufacturers. Each barrier was placed between a readily ignitable fabric and foam filling material. These barriers are

designed to swell when heated and cause the ignited fabric to self-extinguish. Three of these intumescent barriers (all variations on one basic composition) did achieve self-extinguishment in the staff's tests.

Five fabrics with laminated fire blockers (i.e., inert, untreated layers glued to the reverse side of each fabric) took slightly longer to ignite than the same five without, although the improvement was not substantial--typically only a few seconds. The untreated nylon pile fabric that required 21 seconds to ignite took 24 seconds with the fire blocker.

The staff also constructed simple, single layer skirts from 15 of the upholstery cover fabrics, including fabrics with FR backcoating and laminated fire blockers. These were tested in a vertical orientation with the flame impinged on the bottom edge. All ignited within 6 seconds; the wool and FR backcoated fabrics self-extinguished. Although these skirts were not typical constructions--most skirts are multi-layer--they illustrate that performance differences exist among tested fabrics.

The preliminary bench scale upholstery cover fabric test results demonstrate that some current fabrics resist small open flame ignition for considerably longer than others. The tests also suggest that FR materials, such as treated backcoatings and certain intumescent barriers, are a) feasible for use with a variety of widely used existing fabrics, and b) can significantly improve ignition resistance and the likelihood of self-extinguishment.

Four dust cover fabrics were evaluated using the bench scale test method, in which horizontal, single layer specimens were tested with the flame impinged in the center. Included were: a typical nonwoven, inherently flame resistant polypropylene; a once-popular but now less commonly used woven cellulosic/thermoplastic blend; and two different nonwoven aramids that are inherently flame resistant but are not used in residential market furniture. The woven blend specimen ignited in 2 seconds and was completely consumed in 5 seconds. The polypropylene melted away, leaving a hole, but did not ignite (i.e., sustain further combustion). The two aramids did not ignite or melt, even with flame applications of up to 2 minutes. These experiments reflect the performance of conventional dust covers in the full scale tests and illustrate the protective capability of some currently-available materials.

b) **Filling Materials.** In addition to testing fabrics, the staff examined the effects of different filling materials on small open flame ignition performance. FR-treated foams are commonly used to meet requirements in California and the U.K.

For baseline measurements, the staff tested a widely used conventional (non-FR) polyurethane foam by itself (no cover material) in the seating area mockup configuration. After 2 seconds of flame exposure, this foam ignited but often self-extinguished; after 3 seconds, it consistently ignited and continued to burn.

A mockup with a typical cellulosic/thermoplastic blend fabric over the same foam ignited in about 7 seconds and continued to burn. A layer of polyester batting between the fabric and foam did not affect ignition time significantly.

The staff also tested FR foams from the California and British full scale test chairs, along with conventional foam, in mockups with two typical upholstery cover fabrics, a 100% cellulosic and a cellulosic/thermoplastic blend. Fabric ignition times were essentially the same when tested with and without the FR foams, and similar amounts of both FR and non-FR foams melted away due to heat from the burning fabrics.

These results support the staff's full scale test findings that filling materials are much less important than cover materials in determining small open flame ignition performance. Although some FR foams may not sustain combustion (thereby limiting the fire), those tested did not prevent ignition or promote self-extinguishment of cover materials in mockup tests.

3. Interlaboratory Study

Performance standard test methods are often themselves tested to establish that they are repeatable, i.e., that different laboratories can run the tests and obtain similar results, and are reproducible, i.e., that similar test results are obtained by a single laboratory when testing multiple specimens. Replicate studies using different laboratories are generally used to explore these issues, especially for flammability performance tests, which are generally regarded as being subject to some inherent variability.

To verify that the test fixture in CPSC's bench scale furniture test method could be operated without difficulty by other laboratories, that the experimental instructions were appropriate, and that reasonably similar test results could be obtained among laboratories using the test method, CPSC sponsored a limited interlaboratory study in the Fall of 1996. Three outside laboratories (in addition to CPSC) participated: Drexel Heritage Furniture Co., a furniture manufacturer; the California BHF; and NIST. A report on the results of the study appears along with a copy of the bench scale test method at Tab E.

Four upholstery cover fabrics and three dust cover fabrics, representing a range of expected ignition characteristics, were

chosen for the study. The study was "blind" in that participants were not told anything about the materials being tested. CPSC provided training, shipped samples, test fixture hardware, burners, specimen holders and data recording forms, as well as written general instructions, the test protocol, and the fixture operation manual, to each laboratory.

The three laboratories performed the tests and reported back with test results, problems, suggestions and other comments. A variety of minor problems were encountered; these led to adjustments or other improvements in the instructions, procedures and equipment. The staff concludes from this limited interlaboratory study that other laboratories and individuals with fire testing backgrounds can follow the test procedures correctly, operate the test equipment and obtain reasonably consistent results. This study supports the general feasibility of the CPSC bench scale small open flame test method. A larger and more formal interlaboratory study would provide additional information on the repeatability and reproducibility of the test method.

4. Potential Effects of Improved Small Open Flame Performance on Cigarette Ignitability

The increased use of cigarette ignition resistant materials, such as thermoplastic fabrics and polyurethane and polyester fillings, is widely suspected to have had an adverse impact on the open flame ignitability and burning behavior of furniture once ignited. Potential side effects attributed to improved cigarette ignition propensity include rapid flame spread, high heat release and toxic smoke production.

The converse of this relationship, i.e., that open flame performance improvements tend to worsen cigarette ignitability, may also be true for some upholstery cover materials: the predominantly cellulosic fabrics and fillings of the 1940s and 1950s would generally resist small open flame ignition for longer periods, at the expense of poorer resistance to smoldering cigarettes. A basic tenet of the staff's technical work is that any small open flame standard should, at a minimum, not increase the risk of cigarette ignited fire losses. The use of certain materials may achieve this objective, and even reduce cigarette ignitability.

CPSC's laboratory testing demonstrates that most currently used upholstered furniture resists cigarette ignition but ignites from small open flames in less than 15 seconds, and tends not to self-extinguish once ignited. Certain inherently flame-resistant materials, however, like many leathers and wools, may be expected to resist both small open flames and cigarettes. Certain FR technology applications for other fabrics may also achieve this.

A variety of FR systems, including direct fiber or fabric treatments, backcoatings, laminates, inert fire blocking barriers, and chemically intumescent barriers that cause burning fabrics to self-extinguish, are available for use or are being used in furniture and other textile-containing products. FR treated fabrics are widely used in the U.K., where both open flame and cigarette ignition requirements exist. Although it may be more difficult to FR treat some fabrics than others, the U.K. experience suggests that these approaches hold promise for most materials. Thus, not only might there be no adverse impact on cigarette ignitability with such products, but there might also be cigarette fire reduction benefits, to the extent that FR treatments were used on otherwise cigarette ignitable fabrics.

Since U.S. residential furniture is not currently produced with FR fabrics, CPSC tested none in any of the full scale tests. The staff did, however, conduct bench scale cigarette tests with 9 different upholstery cover fabrics that performed well in small open flame tests: a blended cellulosic/thermoplastic fabric and a 100% thermoplastic (olefin) FR backcoated fabric from U.S. suppliers; a currently used 100% thermoplastic (nylon pile) untreated fabric; a heavyweight 100% cellulosic fabric obtained from a U.K. supplier; and 5 of the predominantly cellulosic U.K. FR treated fabrics. Details of these tests appear in the laboratory reports at Tab D.

In mockup tests, the U.S. FR backcoated fabrics either caused the test cigarettes to self-extinguish (i.e., fail to burn their entire length) by heat dissipation, or allowed cigarettes to burn (both with acceptably little char). The untreated nylon fabric allowed the cigarettes to burn but prevented any charring. These and many other currently used, non-FR fabrics were tested in accordance with the UFAC Fabric Classification Test Method (a test that does not guarantee composite ignition resistance but is a widely used indicator). The backcoated fabrics and the nylon fabric were Class I (least ignitable) fabrics in the UFAC tests.

The heavyweight (17.3 oz/yd^2), 100% cellulosic, non-FR treated U.K. fabric that resisted small open flame ignition for up to 30 seconds ignited from cigarettes in CPSC mockup tests. This fabric is of some concern to the staff, but is not typical of most cellulosic fabrics used in U.S. upholstered furniture. None of the tested U.S. cellulosic fabrics resisted small open flame ignition for more than 20 seconds.

Five of the 7 U.K. FR fabrics that performed well in small open flame tests were also tested for cigarette ignitability, using either the UFAC mockup or a similar CPSC mockup configuration (in 2 cases insufficient amounts of material were provided to construct any cigarette mockups). Four of these five consistently resisted cigarette ignition; one of the 15 test cigarettes ignited on the fifth sample.

The range of results in the cigarette ignition tests reveals that readily available FR technologies, such as backcoatings and intumescent barriers, that are effective in small open flame tests may help reduce cigarette fire losses as well. Increased use of some untreated fabrics may also help reduce both risks. The staff will continue to conduct tests to evaluate the likely cigarette ignition effectiveness of various FR technologies.

Additional information relevant to the relation between open flame and cigarette ignitability has recently become available in a study conducted for the Commission of the European Union by seven laboratories and the European Federation of Furniture Manufacturers (U.E.A.). This study reportedly evaluated the cigarette and small open flame ignition performance of a matrix, or "grid," of 360 different combinations of upholstery cover fabrics and filling materials, including many FR materials. Existing and proposed standards issued by the European Committee for Standardization (Comité Européan de Normalisation, or CEN), EN 1021-1 for cigarettes, and prEN 1021-2 for small open flames (both derived from tests in BS 5852), were used to measure performance. A review of the issues raised by the grid study appears at Tab E.

Unpublished data from the study suggest that, although most combinations of FR materials provide protection from both small open flames and cigarettes, some combinations of small open flame resistant materials may be prone to cigarette ignition. Various flammability experts have expressed concern about this issue, noting basic differences between the physics of smoldering and open flame ignition. This does not necessarily conflict with CPSC's testing results. The CEN standard test specifications are somewhat different than those in CPSC's bench scale method (e.g., a 15 second flame exposure time in prEN 1021-2, compared to 20 seconds in the CPSC staff draft standard); thus, the CPSC staff draft standard would probably impose greater restrictions on the use of cigarette ignitable fabrics. The staff is seeking more data about the products tested in the grid study to understand the implications of the study for CPSC's activities.

B. Fire Retardant Chemical Toxicity Review

The most promising method of reducing the risk to consumers from small open flame ignited upholstered furniture fires involves FR treatments in cover fabrics. There is some concern about possible health risks associated with exposure to some such chemicals. Thus, the staff reviewed available information and conducted limited laboratory tests to investigate the potential acute and chronic toxic hazards of known candidate FR chemicals.

Fire retardant chemicals are widely used in products used by consumers, including plastics (e.g., television and computer cabinets, power tools, and cooking and other heat-producing

appliances) and textiles (e.g., carpets, clothing, mattresses, and upholstery items). Furniture meeting California TB-117 contains FR treated fillings. FR treated fabrics are used in virtually all automotive and airline seats, and are often incorporated into commercial or industrial furniture. In the U.K., most residential upholstered furniture contains FR treated filling materials and FR fabrics. Fabric treatments may be applied by immersion, incorporated in the polymeric matrices of fabrics or barriers, or--most commonly--inclusion in fabric backcoatings. FR fabrics are not used in U.S. residential upholstered furniture, although residential upholstery fabrics are often (non-FR) backcoated for stability or durability.

The Federal Hazardous Substances Act (FHSA) defines as "toxic" any substance that has the capacity to produce personal injury or illness through ingestion, inhalation or absorption. A "hazardous" substance under the FHSA is any which is toxic and may cause substantial illness or injury as a proximate result of reasonably foreseeable use, including ingestion by children. CPSC's 1996 FHSA chronic hazard guidelines (16 CFR 1500.135) offer criteria for assessing toxicity, potential exposure and bioavailability of chemical substances in consumer products.

The staff reviewed the available information on the potential toxicity of 14 chemicals identified in the scientific literature as ingredients in textile FR treatments, to assess any health risks that could attend the use of such treatments in upholstered furniture fabrics. Two additional chemicals currently used in California FR foam fillings were also reviewed. The staff examined data on dermal and oral toxicity, possible exposure, bioavailability, chronic adverse effects and combustion toxicity. A report on the staff's review appears at Tab F.

While not all of the reviewed FR chemicals are currently used in upholstery fabrics, several may be candidates for use. No available toxicity studies directly relate to acute or chronic risks that may be posed by exposure to FR chemicals from furniture fabrics; however, a number of studies provide general information on other FR applications. CPSC also conducted chemical extraction studies on samples of FR fabrics to help assess chemical bioavailability. Some data are available in the literature on the relative combustion toxicity of FR fabrics.

Based on existing toxicity information, the staff concluded that the following five of the reviewed chemicals are not toxic:

--Decabromodiphenyl oxide;
--Hexabromocyclododecaine;
--Urea (not a flame retardant by itself, but often used in combination with others);
--Phenol isopropiyated phosphate; and
--Phosphonic acid.

The two FR's in polyurethane foams--triphenyl phosphate and melamine--are also not toxic. Boric acid and ammonium bromide are toxic, but are not water soluble, and would probably not be bioavailable. There is no information on the bioavailability of another acutely toxic chemical, ammonium sulfamate.

Toxicity data were limited or unavailable for three of the identified FR chemicals: phosphorothioic acid, ammonium polyphosphate, and tetrakis-hydroxymethyl phosphonium chloride (in polymeric combination with urea). The makeup of these chemicals makes them unlikely to migrate from fabrics or be absorbed dermally.

At least three of the FR's described above have reportedly been used in U.K. furniture: decabromodiphenyl oxide (non-toxic), phosphonic acid (Pyrovatex, non-toxic) and phosphorothioic acid (Proban, may be toxic, limited data). Pyrovatex is also used as an immersion-applied flame retardant in some U.S. children's sleepwear.

Three of the identified FR chemicals--two chlorinated phosphates and antimony trioxide--are probable human carcinogens under the methodology set forth in CPSC's chronic hazard guidelines. One of these, tris (1,3-dichloroisopropyl) phosphate (TDCP, Fyrol FR-2), is similar but not identical to tris (2,3-dibromopropyl) phosphate (TRIS), a carcinogenic substance once used as a topical FR treatment in 100% polyester and acetate- or triacetate-containing children's sleepwear to meet the Commission's flammability regulations (16 CFR 1615 & 1616). In 1977, the Commission issued an interpretation that TRIS-treated sleepwear was banned under Section 2(q)(1)(A) of the FHSA, due to the potential for TRIS to be released and absorbed or ingested.

Antimony trioxide is typically used in combination with decabromodiphenyl oxide, and is contained in the backcoatings of most of the treated fabric samples obtained from the U.K. Hexabromocyclododecane is reportedly an alternative to decabromodiphenyl oxide that does not require the use of antimony trioxide in FR formulations.

The potential for consumer exposure to FR chemicals depends largely on their application method. Treatments applied only to the surface of a fabric may pose the greatest potential for exposure. In the past, FR chemical treatments were applied to the surfaces of cotton children's sleepwear such that the FR chemicals could be released, upon exposure to saline (sweat) or urine, onto the skin. In upholstery fabrics, which are not routinely washed, the FR chemical treatment is usually incorporated into a durable fabric backcoating, barrier or fiber matrix within the fabric. Treatments in a polymer matrix backcoating on fabrics would have to migrate from the matrix through the fabric to the surface; treatments in barriers would

have to migrate not only through the barrier itself but also through the cover fabric. Treatments in fibers would also have to migrate through to the surface of the fabric.

Chemical extractions were performed on 13 FR treated (12 antimony-based plus 1 phosphorous-based) fabrics, using water, saline solution, n-hexane, and two different strengths of hydrochloric acid (HCl) solvent solutions. A summary of this study appears among the laboratory reports at Tab D. Only trace amounts (0.01%) of antimony trioxide were extracted from any fabrics with 4N HCl; a higher level (1.7%) of (non-toxic) phosphorous was extracted from one fabric with 0.1N HCl. No FR chemicals were found using less powerful extractants, including hexane, which is chemically similar to common solvent-based dry cleaning agents. This suggests that, for the limited sample of fabrics, exposure from normal use or cleaning is unlikely.

Another factor affecting the low likely bioavailability of FR chemicals is the small amounts that would be used in cover fabrics--an average of about 20 ounces in an entire piece of furniture. It should also be noted that the water pre-soak conditioning requirement in the draft standard, intended to ensure FR treatment durability, would also have the likely effect of precluding the use of readily soluble, surface treatments that might be released over the life of the product.

Another concern is the potential effect of FR chemicals on the post-ignition combustion toxicity of upholstered furniture. All upholstered furniture materials generate toxic smoke once ignited. Conventional polyurethane foams contain significant amounts of nitrogen which, when burned, may produce hydrogen cyanide. Additional nitrogenous FR chemicals may increase the combustion toxicity hazard; the extent of any increase depends chiefly on the amounts of chemically reactive material, like urea, in the furniture item (e.g., in foam fillings). In addition, brominated biphenyl FR's may produce highly toxic bromofurans when burned. The extent of any resultant increased risk from the use of these chemicals would, however, likely be obscured in a fire by the primary acute risk of carbon monoxide (CO) poisoning: most fire deaths are caused by inhalation of CO, the principal toxicant released by burning upholstered furniture. FR chemical toxicant production would be small by comparison.

To obtain additional review of the staff's analysis of potential hazards associated with chemicals that might be used to improve the small open flame performance of upholstered furniture, the staff consulted with individuals with the National Toxicology Program (NTP) and experts at the Federal Aviation Administration's Civil Aeronautical Medical Institute (CAMI). Both of these organizations are familiar with FR chemical toxicity issues. They considered the staff's preliminary review to be technically complete, and the staff's conclusions to be

scientifically sound. Copies of the staff's correspondence with these groups appears at Tab F.

The staff is also aware of an ongoing study in the U.K. of FR chemical toxicity and environmental effects, sponsored by the Department of Trade and Industry (DTI). This study, which is expected to be completed in early 1998, may provide more information relevant to CPSC's activities.

In summary, the staff's preliminary toxicity review, along with the information provided by the other government experts, suggests that a number of FR chemicals, including some already in use, may be appropriate for use in upholstered furniture and are either not toxic or not bioavailable. For one chronically toxic, likely candidate FR chemical (antimony trioxide) in the most commonly used treatment method (backcoating), CPSC laboratory analysis indicates that consumers would not be exposed to the FR chemical as a result of household use. Insufficient data are available, however, to evaluate potential exposure or chronic risks associated with all of the known FR treatments that might be used in upholstered furniture fabrics. The staff concludes that additional information on candidate FR chemical treatments is needed to assure that they would not, if used in upholstered furniture, present any such risks.

C. Small Open Flame Standard Development

Based on the available technical data and related information, the staff prepared a draft standard to address the risk of upholstered furniture fires ignited by small open flames. Factors influencing the development of the draft standard are discussed below. The draft standard and supporting technical staff reports appear at Tab G.

1. Review of Existing Standards

The principal existing small open flame upholstered furniture standards are California TB-117 and the British standard, BS 5852. TB-117 and BS 5852 address both cigarette and small open flame ignition. The staff reviewed the general approach and requirements of these standards to determine whether elements of either should be incorporated into a draft CPSC standard.

TB-117 contains performance tests and requirements for individual components. Complying components may be used in products offered for sale in California. The TB-117 cover fabric test is from the Commission's general wearing apparel standard (16 CFR 1610, originally issued in a U.S. Department of Commerce Commercial Standard in 1953). This test involves a 1 second exposure to a very small flame applied to fabrics held at a 45° angle. TB-117 is widely considered to be a minimal standard; virtually all modern upholstery coverings pass this test. TB-117

also requires that filling materials be tested, but not in combination with fabrics or other materials. CPSC's full scale tests and small scale test evaluation showed that TB-117 component results were not predictive of full scale performance.

The British standard, BS 5852, contains the basic performance tests referenced in the U.K.'s Furniture and Furnishings (Fire) (Safety) Regulations 1988 (Amended). BS 5852 contains composite mockup tests (using assembled components identical to those in the final product); the Regulations, however, prescribe mockup tests of specified components in combination with standard (rather than actual) materials. Compliance for domestic (residential) U.K. furniture is established by demonstrating resistance to ignition both from cigarettes and from small open flames--the so-called "match test."

CPSC's full scale tests and small scale test evaluation showed that BS 5852 mockup test results consistently predicted full scale ignition performance. CPSC's bench scale tests, however, showed that small open flame ignition is controlled by the physical properties of upholstery cover fabric, and is not materially affected by filling material characteristics. This is in contrast to the cigarette ignition process, which is strongly influenced by the type of filling material, construction geometry, etc. The staff concludes that a mockup test of fabrics with a standard filling material adequately measures small open flame performance.

The staff selected a mockup approach using upholstery cover fabrics and standard, non-FR foam filling material as the most reasonable indicator of the performance of finished products. This is similar to the approach taken in the U.K. regulations (i.e., a variation on the British standard, BS 5852); it also parallels the approach taken in the UFAC Voluntary Action Program to classify fabrics as to cigarette ignition resistance.

2. Ignition Prevention and Sustained Combustion

Ignition is the first phase of the combustion process. Sustained combustion is the progression of the fire after ignition occurs. Flammability standards generally seek to limit one or both of these phenomena. When a test flame is applied to a material specimen, subsequent continued combustion in the form of visible flaming, glowing or smoldering can be readily measured. Other outcomes related to fire "growth," such as heat release (an indicator of the potential for room flashover), mass loss and toxic smoke production, are also measurable as combustion advances. Such measurements are closely related to escape time and room tenability conditions, and are specified for certain public occupancies in some model building codes.

The draft standard developed by the staff defines ignition as any continued combustion of a test specimen observed after removal of the test flame. This definition is consistent with the objective of preventing sustained combustion beyond the early stages of the fire, before flames can spread throughout or beyond the ignited piece of furniture. Resistance to ignition and early stage combustion obviates the need to control the deadly high heat and smoke production associated with larger fires. This approach is also supported by the analysis of the national fire data, which identified small flame ignitions, especially childplay with lighters and matches, as the primary cause of open flame ignition.

3. Test Method

The draft standard developed by the staff contains most elements of the bench scale method used in CPSC's laboratory tests. The major issues considered involved the specifications for the mockup configuration and test fixture, and the selection of test locations, ignition source, and flame exposure time.

a) Mockup Configuration. The draft standard incorporates a seating area mockup test in which cover fabrics (and barriers, if used) are tested over a specified, standard polyurethane foam. The mockup configuration is similar to that in BS 5852. Dust cover materials are tested alone, in a horizontal orientation.

The seating area mockup using standard foam should provide a reasonable measure of performance for virtually all upholstery cover fabrics in any construction. The dust cover component test also provides a reasonable means of qualifying materials for use in different constructions. This approach minimizes testing burdens on manufacturers and allows fabric and material suppliers reasonable flexibility in testing to support the issuance of guarantees to manufacturers under the FFA. The draft standard provides that manufacturers may, at their option, test the materials used in the finished product, e.g., with FR barriers or qualifying dust cover constructions; this avoids unnecessary restrictions on materials usage.

The bench scale experimental data demonstrate no significant effect of different filling materials on seating area mockup ignitability or early post-ignition behavior. FR foams taken from California and U.K. chairs did not improve ignition resistance or cause mockups to self-extinguish within the 2 minute observation period. The staff concluded that tests on every fabric and filling material combination are not warranted.

b) Test Fixture. An updated version of the staff-designed and -constructed flammability test fixture is used to perform tests described in the draft standard. This automatic test apparatus precisely delivers a consistent, timed test flame. It

is modular to facilitate portability and convenience and to reduce testing costs. The staff also prepared an operator's guide for use with the fixture. Photographs of the test fixture appear in the draft standard and in the operator's guide appended to the draft standard, both at Tab G.

c) Test Locations. The IDI study identified the seating area, including the seat cushion and inside back and sides, as the ignition location most often reported in the investigated small open flame furniture fires. This, coupled with the observed poor ignition resistance of most current upholstery cover fabrics, strongly suggests a need to test for small open flame protection in this area. The seat/back crevice location in the draft standard--virtually a vertical fabric test--provides an adequate test for seating surfaces.

The fire investigations cited relatively few dust cover ignitions--about 10% of known locations. This level, while clearly not as great a concern as that for seating areas, still represents a hazard, especially for long-legged or skirtless products. CPSC laboratory tests show that the most popular and least expensive dust cover material in current use is already ignition resistant and may be acceptable in constructions without ignitable materials immediately above the dust cover; thus, the likely cost of dust cover performance provisions would probably be low. On balance, the staff considers it reasonable to include dust cover requirements in the draft CPSC standard.

Skirts were not significantly involved in ignition among the investigated cases (only 1 incident out of 38 in which the location was specified, a lower incidence than observed in the 1994 IDI review). This may be due in part to a reported decline in the popularity of skirts on upholstered furniture. Given the low incidence of skirt involvement, and the likely difficulty and cost of devising ignition resistant skirts, the staff did not include a skirt test in the draft standard. Fabrics used to pass the seating area test may also be used in the assembly of skirts; thus, some level of protection may be afforded even without a specific skirt requirement.

d) Ignition Source. The analysis of fire hazard data indicated a need for tests to simulate a flame like that of a match, lighter or candle. The draft CPSC standard uses the small flame "Ignition Source 1" in BS 5852. The CPSC's butane diffusion flame is delivered through an approximately 7mm inside diameter burner, with a pressure-regulated gas supply system incorporating a flowmeter calibrated to supply 45ml/minute, for a flame height of approximately 35mm. The staff obtained measurements of the heat energy (or "flux") and temperature output of typical small flame sources, and determined that the test flame reasonably replicates the heat of small open flame sources. A staff report on this issue appears at Tab G.

e) Flame Exposure Time. The staff's goal in selecting a flame exposure time was to adopt the least severe test (i.e., the shortest time possible) that reasonably discriminates between materials that readily ignite and continue to burn and those that do not, without exceeding practical technological and cost limits. The staff incorporated a 20 second flame exposure time into each test after considering several factors, including laboratory experience with different fabrics and dust cover constructions, typical match and lighter continuous burn times, information on child fireplay behavior, and possible effects on cigarette ignition resistance.

The full and bench scale laboratory tests provided data on the effect of various flame exposure times on ignition times and post-ignition behavior. For example, a seating area mockup that ignited from a 15 second exposure but self-extinguished within 2 minutes may burn until consumed when exposed for 20 seconds. This illustrates the sensitivity of flame exposure time on fabric performance, and demonstrates that a narrow range of alternative times may yield quite different results.

The staff also conducted experiments to establish the range of match and lighter burn times. While match burn times were generally in the 10-30 second range, the experiments suggested that a lighter (e.g., in the hands of a child) or a candle could produce a continuous flame for up to several minutes.

Available information on child fireplay suggests that young children, who are most often cited as fire starters, are fascinated with fire but not generally motivated to ignite objects such as chairs or sofas. Further, many young children would not be expected to hold a flame source in one place for more than several seconds; a child who engages in the relatively focused behavior of holding a flame in place for an extended period of time is persistent beyond mere fire play. The staff recognizes that intentional ignitions are difficult to address by means of a product flammability standard. The 20 second exposure time in the draft standard is intended to reduce inadvertent ignitions.

The potential use of some cigarette ignition prone, 100% cellulosic upholstery cover fabrics also influences the evaluation of flame exposure time alternatives. Laboratory tests identified several heavyweight cellulosics that resisted small open flame ignition for between 15 and 20 seconds and sometimes self-extinguished; some of these did not resist cigarette ignition in CPSC or UFAC mockup tests. The staff concludes that a 15 second flame exposure time could prompt the use of more cigarette ignition prone fabrics, a highly undesirable risk trade-off. Only one tested cellulosic, non-FR treated fabric resisted small open flame ignition for more than 20 seconds and ignited from cigarettes. Overall, the staff concludes that a 20

second flame exposure time would not lead to any significant increase in the use of cigarette-ignitable seating area fabrics.

Typical, nonwoven dust covers that melt away from a flame pose little hazard if no ignitable materials are immediately above. For constructions without nearby ignitable interior materials, exposure time from a stationary flame source is almost irrelevant. When such ignitable materials are present, however, they must be protected, or must not contribute to the fire themselves. Since dust covers may be directly below seating area materials, the same level of protection is built into both tests.

4. Performance Criteria

The draft standard incorporates two basic small open flame performance requirements, for ignition (i.e., continuing combustion) and flame progression. For seating area and dust cover materials tested in accordance with the standard:

1. specimens shall self-extinguish (i.e., cease flaming, glowing or smoldering) within 2 minutes after the test flame is removed; and

2. no flaming or glowing shall progress to any edge of the specimen, as measured on any surface plane of the specimen.

Upholstery cover materials that meet the performance criteria above would be acceptable in upholstered furniture in combination with any filling materials. Dust covers that meet the performance criteria and do not split or melt when tested would also be acceptable for use in any furniture. Dust covers that split or melt, however, would only be acceptable in furniture constructions without ignitable materials within 1 inch of the horizontal plane of the dust cover, within (but not including) the bottom frame of the finished piece. Thus, interior materials within 1 inch of dust covers that melt or split would also be subject to the dust cover test. Furniture without dust covers (like some recliners and other "motion" furniture) would only be subject to the seating area provisions.

5. Other General Requirements

The draft standard contains other provisions that complement the performance criteria. These include conditioning requirements for temperature and humidity of test rooms and sample storage facilities, and for sample/specimen handling and preparation, including a water pre-soak for treated fabrics. The water pre-soak provision would eliminate the use of non-durable, water-soluble FR treatments (e.g., on fabric surfaces), and would eliminate the need for cleaning or other durability requirements.

6. Testing & Certification

The draft standard describes tests CPSC may conduct to establish small open flame performance. It contains no specific requirements for testing, recordkeeping or other certification by manufacturers and importers. Firms could perform the CPSC mockup tests or tests using the actual materials in the assembled item of furniture to demonstrate performance. These alternate tests would enable manufacturers to use any acceptable combinations of seating area materials, and would allow dust cover materials that melt but do not sustain combustion to be used in constructions without flammable interior materials in close proximity.

D. Economic Considerations

The staff analyzed the economic effects of various small open flame hazard reduction options. This analysis discusses products and industries that may be affected by such actions, and potential benefits and costs of the draft CPSC standard and significant alternatives. The economic analysis report appears at Tab H.

1. Products Affected

A small open flame standard or other action may affect a variety of upholstered furniture products, as well as component materials such as fabrics. A summary of the latest information on these products is presented below.

a) Upholstered Furniture. An estimated 1,500-2,000 U.S. companies manufacture or import upholstered household furniture. The market is fairly concentrated among the larger firms. The top four companies accounted for 25 percent of the total value of upholstered furniture shipments in 1992, and the 50 largest companies accounted for 69 percent. Despite a recent trend toward increased concentration as larger firms acquired smaller ones, the industry is almost entirely comprised of small firms.

The estimated wholesale value of domestic shipments of upholstered household furniture in 1996 was $7.9 billion. With net imports of about $0.4 billion, the value of total shipments was about $8.3 billion. The leading country of origin for imported furniture was Italy, accounting for 51 percent of upholstered furniture imports. The total annual retail value of upholstered furniture sales to consumers is about $16 billion. The number of upholstered furniture pieces purchased annually is in the range of 25-30 million units.

b) Upholstery Cover Materials. There are 100-200 manufacturers of fabrics and other upholstery cover materials for residential furniture. These firms include textile mills that produce finished fabrics, and textile finishers that purchase

unfinished goods and perform additional operations, such as printing and dyeing. The largest five companies reportedly accounted for about half of the nearly $2 billion domestic upholstery cover market in 1993. The top 15 had combined sales of $1.6 billion in 1993, or about 80 percent of the market. As with upholstered furniture, a number of recent consolidations have occurred as larger firms acquired smaller competitors.

U.S upholstery fabric production in 1996 was over 500 million square yards. The major end-use markets for upholstery fabrics are in upholstered furniture and automobiles. Estimated annual consumption of cover fabrics for the production of upholstered furniture is about 300-350 million square yards, excluding leather. The manufacture of slipcovers, throws, and futon covers consumes an additional 50 million square yards.

About half of the upholstery cover material used in furniture is primarily thermoplastic (e.g., polyester, polypropylene, polyolefin); about one-third is primarily cellulosic (predominantly cotton). Leather upholstery coverings are reported to be increasingly popular, and may account for 10-15% of the market.

c) Other Products. A small open flame standard could include in its scope a number of other upholstery products. These include futons, outdoor furniture, slipcovers, throws, and most commercial, hotel/motel and other non-residential items generally referred to as "contract" furniture.

Futons are upholstered items intended for use as both seating furniture and bedding. As bedding products, they are subject to the Commission's regulations for mattresses and mattress pads (16 CFR 1632), and are generally FR treated to resist cigarette ignition. While futons are clearly marketed as seating products, and are not manufactured to be open flame resistant, they are not identified separately in the national fire loss data, and are not among the products cited in the fire investigation study. Similarly, no outdoor furniture products are identified in any of the hazard data.

While the staff is aware of a small number of furniture fires involving slipcovers or throws, no data are available to establish the role of the covering. Further, the ANPR's description of articles or components of upholstered furniture does not encompass these items.

The available evidence indicates that "contract" furniture, manufactured to order by commercial purchasers for use in offices, hotels, schools, hospitals, and various other non-residential occupancies or temporary residences, does not contribute significantly to the small open flame ignition hazard. For example, although hotels and motels are included in the fire

loss estimates for residential fires, these occupancies accounted for only about 20 fires in 1994 (about 0.5% of the residential open flame total for upholstered furniture) and no deaths. Products like office desk chairs, however, that are distributed for sale through retail channels and that may reasonably be expected to be used in home offices or other household locations, may be exposed to small open flame sources as would other residential furniture.

The staff concludes that these categories of products are probably not significantly involved in small open flame ignited fires. Little if any benefits to consumers would result from their inclusion within the scope of the draft standard.

2. Potential Benefits

The potential benefits of a standard or other action would be comprised, in part, of reductions in fire losses attributable to ignitions of upholstered furniture by matches, lighters, or candles. As shown in Table 1, these small open flame fire losses include a 1990-1994 annual average of 100 deaths, 460 injuries and $46 million in property damage, for estimated societal costs of about $625 million.

An average of about 40 of the 100 deaths were attributable to fires involving cigarette lighters. CPSC's 1993 rule for lighters (16 CFR 1210, effective July 1994) addresses the risk of fires started by children under age 5 playing with lighters. Thus, the lighter rule would reduce upholstered furniture fire losses. An adjusted baseline for estimating the potential benefits of an upholstered furniture standard can be calculated that takes into account the projected effect of the lighter rule.

About 90% of lighter fire deaths were related to young children playing. The lighter rule is projected to reduce fire deaths by about 70%. Thus, for the upholstered furniture subcategory, the staff estimates that the lighter rule could have saved about 40 X 0.9 X 0.7 = 25 fire related deaths per year, had the rule been in effect during that period. Similar calculations can be made for injuries and property damage. Thus, of the estimated $625 million annual average societal cost of small open flame upholstered furniture fire losses, slightly over $150 million would have been averted as a result of the lighter rule.

The remaining average annual losses from lighter, match, and candle ignitions of upholstered furniture would have been about 75 deaths, 360 injuries, and $40 million in property damage. The estimated societal cost of these remaining losses is about $470 million; this represents the maximum potential benefits of additional action--beyond the lighter rule--to reduce small open flame ignited furniture fire losses.

The present value of estimated small open flame hazard costs over the 14-year life of a piece of furniture is about $16 per unit (calculated for the approximately 90% of items in use estimated to present the hazard). This would be the benefits if product changes eliminated 100% of fires started by matches, lighters, and candles. The actual benefits would be a function of the standard's effectiveness at reducing such losses.

A likely method of improving small open flame ignition performance is to use FR fabrics; such fabrics may be inherently flame resistant by virtue of their composition or construction, may be used with FR laminates or barriers, or, more commonly, may be chemically treated. CPSC laboratory tests of various FR materials indicate that the use of such materials may be highly effective at improving small open flame ignition performance. For example, using a 70% estimate of effectiveness, the expected present value of open flame-related benefits to society of a small open flame standard would be about $11 per piece of furniture affected, or about $225 million at current production levels. At 80% effectiveness, expected benefits would be about $13 per piece, or about $255 million at current production levels.

FR treatments can also improve the resistance of furniture to ignition by a smoldering ignition source, such as a cigarette. Based on CPSC's laboratory test data, it is possible that most cigarette ignition prone fabrics could be made to resist cigarette ignition by virtue of modifications made to improve small open flame performance. Thus, the benefits of a small open flame standard derive not only from its effectiveness in reducing losses from fires started by matches, lighters, and candles, but also from reduced cigarette ignited fire losses. In CPSC's laboratory tests, nearly all FR backcoated fabrics were cigarette ignition resistant--even those that would otherwise be expected to ignite. In a conservative example, if 50% of all cigarette ignited fire losses were averted, the expected present value of these additional benefits would be about $29 per affected piece, or about $570-690 million at current production levels. The midpoint of this range of estimated annual cigarette fire loss reduction benefits is $630 million.

It is also possible that product modifications to improve small open flame performance would alter the burning characteristics of furniture when subjected to larger open flame sources, or when the furniture is not the first item ignited. FR treated fabrics could reduce fire growth in such circumstances, and could afford additional time for fire detection, fire suppression, or escape. The extent of any such effect is not known; however, only a slight increase is likely in overall expected benefits. Thus, no large open flame ignited fire loss reductions are included in the benefit estimates above.

3. Potential Costs & Other Effects

A standard may lead to changes in materials used in seating areas and dust covers of upholstered furniture. Skirt materials could also be affected. The cost to consumers may be substantial. Potential impacts related to each of the basic test elements of the staff's draft standard are discussed below.

a) Seating Area Test. Under the draft standard, suppliers could certify component materials. This would minimize the total testing burden of the standard since the same fabric would not have to be tested by furniture manufacturers. If fabric purchasers relied on certification by their suppliers, their only significant cost increase would be the higher cost of treated fabrics, assuming that changes to the fabrics would not require other major modifications in equipment or labor.

Testing is not specified in the draft standard, but may be performed by fabric suppliers. If tests were performed by manufacturers for each production run, total annual industry testing costs may range from about $2-3 million. If tests were performed by outside laboratories, annual industry costs could be up to about $11 million (including about $1 million for the cost of test fabrics). Such costs would be passed on to furniture manufacturers in prices of upholstery cover materials.

The draft seating area test is similar to the "match resistance" requirements of the 1988 U.K. regulations (based on the British standard, BS 5852). Fabric manufacturers, including some major U.S. fabric companies, currently supply fabrics that meet this standard. Means of compliance with this test include incorporating FR chemicals in a backcoating, applying FR chemicals to the fabric in a way that withstands pre-soaking requirements, and including FR chemicals into polymeric fibers that are used to make upholstery cover fabrics. Most leather upholstery covers are generally expected to perform well in the seating area test without FR treatments.

The U.K. experience with a small open flame testing requirement suggests increased fabric costs to furniture manufacturers generally in the range of $1.00-1.25 per linear yard for most fabrics. The average retail price increase per item of furniture requiring changes is estimated to be $22-28. Likely per-unit price increases for products with less upholstery fabric, such as dining and desk chairs, would be in the $4-6 range. Annual upholstered furniture shipments range from 25-30 million units, of which perhaps 80 percent would probably involve price increases due to FR treatments of upholstery cover fabrics. Fabric treatments necessary to pass the seating area test could result in increased consumer expenditures for upholstered furniture totaling about $460-710 million annually.

Officials of British government, textile, chemical, and furniture manufacturing organizations have reported that technical and supply problems were initially encountered under the U.K. regulations, but that these have, for the most part, been overcome. The British Interior Textiles Association noted that equipment necessary to apply FR treatments to fabrics was already in use by fabric finishers for other purposes. Expenditures in capital equipment were generally not necessary in order to produce fabrics that comply with the British match test.

The use of backcoatings or other FR materials in U.K. upholstered furniture has also reportedly had some adverse effects on aesthetics and durability. While some FR treatment suppliers state that such problems have been largely overcome, these effects--which are not readily quantifiable--may still represent a cost to suppliers of certain fabrics.

It should be noted that lighter weight upholstery fabrics are used for other purposes, such as window treatments. If such fabrics continued to be available without FR treatments, wholesalers and retailers may have to increase their number of stock keeping units (SKU's) to differentiate between fabrics.

b) Dust Cover Test. Dust cover tests might also be done by or for suppliers of the dust cover materials, who could then provide certification to furniture manufacturers that the materials would perform acceptably in the dust cover test. Nonwoven fabrics commonly used by the furniture industry can pass this test, because they melt away from the flame source without progressive combustion. Constructions that might require modifications would be those having combustible materials in close proximity to (i.e., within 1 inch of) the dust cover. Such constructions could require modifications to create a wider gap between the dust cover and other materials, the addition of materials above the dust cover that would resist ignition, or the use of dust covers that resist ignition and protect interior materials above the dust cover from ignition.

The cost of meeting the dust cover requirements would be small compared to the cost of the seating area requirements. Assuming no significant change in dust cover usage, total yearly costs to consumers in the form of higher retail prices may be about $1.5-7.5 million. Since these fabrics are lightweight and are not subjected to wear, relatively inexpensive FR treatments might be developed to allow the use of woven fabrics with little increase in costs. Most manufacturers using woven dust covers would probably switch to the lower cost alternative of currently available nonwoven fabrics; in some constructions, firms may use higher cost, fire blocking materials.

c) Skirt Test. Although the staff developed a test for skirts, only 1 out of the 76 fires in the IDI study was found to

involve a skirt. Total annual costs to the public related to the skirt test might be $30 to $70 million in the first year of the standard, and $13 to $40 million annually in subsequent years. The average increase faced by consumers at the retail level could range from about $1.60 to $3.60 per piece of upholstered furniture. The staff concludes that the available information does not support the inclusion of a skirt test in the standard.

4. Cost and Benefits Comparison

The estimated cost to consumers of improving small open flame ignition resistance for most kinds of upholstered furniture, by means of FR cover fabrics and dust cover materials, is approximately $23-30 per item. Total estimated annual costs to consumers may be about $460-720 million; the mid-point estimate of this range is $590 million.

CPSC's laboratory tests indicate that a standard could be highly effective at reducing small open flame ignited fire losses. Most of the tested FR backcoated fabrics self extinguished after igniting. If 70-80 percent of small open flame losses were eliminated by a standard, the resulting benefits would have an average present value of about $11-13 per unit. Laboratory testing also indicates that FR treatments can increase the ignition resistance of smolder-prone fabrics that account for most smoking material ignited furniture fires, without worsening the ignitability of existing smolder resistant fabrics. All of the tested FR fabrics that performed well in small open flame tests also resisted cigarette ignition. While the extent of smoking material fire benefits is uncertain, it is reasonable to expect that at least 50% of cigarette ignited fire losses could be prevented by the kinds of improvements expected to meet a small open flame standard. The resulting benefits would have an average present value of about $29 per unit.

A highly (80%) effective small open flame standard would only have to reduce cigarette ignited fire losses by about 20-30% in order to have societal benefits roughly in balance with costs. Thus, a standard that reduces the majority of such losses may have significant net benefits to consumers, depending on the actual extent of its cigarette ignition effectiveness. Using mid points of the estimated ranges of possible benefits and costs, a standard that reduced 80% ($255 million) of small open flame losses and 50% ($630 million) of smoking material fire losses may have annual net fire safety benefits (after subtracting average estimated costs of $590 million) of about $300 million.

5. Small Business Considerations

All but about 30 of the estimated 1,500-2,000 U.S. companies that manufacture or import upholstered furniture have fewer than 500 employees, and are considered to be small. More than half of

all U.S. upholstered furniture manufacturing establishments reportedly have fewer than 20 employees. Thus, a large number of small businesses might be subject to a small open flame standard.

A standard would also affect over 100 mostly-small fabric manufacturers and finishers. Most testing and recordkeeping to ascertain compliance would probably be performed by or for fabric manufacturers. No special skills not already available to these firms would be needed to establish or verify product performance.

The staff incorporated features into its draft standard to minimize potential economic burdens on small businesses, while maintaining an adequate level of safety. No test sampling plan or recordkeeping requirements are included, and the way composite materials are tested allows small furniture manufacturers to rely on tests performed or guarantees issued by fabric suppliers; the fabric suppliers tend more often to be larger firms. Further, one test, for furniture skirts, that might be particularly burdensome for small furniture manufacturers was developed but omitted from the draft standard.

For many small furniture manufacturers, a standard would not have significant adverse effects. Material costs may increase proportional to quantities ordered, but this effect would not be disproportional to firm size.

E. Other Standards Activities

The staff has been following furniture flammability standards-related activities, including voluntary standards efforts in the U.S. and international standards developments. The status of these activities is summarized below.

1. Voluntary Standards

There is no existing U.S. voluntary standard addressing small open flame ignited upholstered furniture fires. The existing UFAC program is directed at cigarette ignition resistance. In its August 15, 1994 letter (at Tab I), UFAC expressed its willingness to consider adopting elements of TB-117 or another applicable standard if appropriate; their follow-up letter of March 3, 1995 stated that UFAC-sponsored tests suggested no significant improvement was associated with the use of materials (i.e., FR foams) required by California TB-117.

UFAC's review has not thus far led them to propose any small open flame tests, construction criteria or product labels. This position reflects, in part, UFAC's understanding that the CPSC staff intended to take the lead in technical work to support a standard, either voluntary or mandatory. CPSC's fire investigation study, laboratory testing and standards development work provide a substantial measure of this technical leadership.

The staff has discussed opportunities for voluntary action with representatives of various industry and standards writing organizations. Several of these groups expressed an interest in participating in a voluntary standards development process. The ASTM E-5.15 Fire Standards Subcommittee on Furnishings and Contents Flammability is one such group, made up of individuals with wide ranging interests in furniture flammability.

In late 1996, this ASTM Subcommittee established a six member work group to consider voluntary action on the small open flame ignition issue. The work group's mission statement noted that they would consider the need for appropriate tests as demonstrated by CPSC data. CPSC staff members attended and presented information at subcommittee and work group meetings. The staff's position has been that sufficient supporting data already exist to begin developing a voluntary standard. In 1997, the work group conducted a review of potentially applicable test methods, and may consider developing new tests, perhaps based on the CPSC staff's draft. The work group's position is that additional data from CPSC's fire investigation study and laboratory testing program are needed before the voluntary test method or standards development effort can proceed further. ASTM's correspondence, including the work group's preliminary report on small open flame test methods, appears at Tab I.

2. International Activities

The staff is aware of various activities in other countries aimed at reducing small open flame and cigarette ignition hazards associated with upholstered furniture. These activities center mainly in Europe, where member nations of the European Union (EU) and European Free Trade Association (EFTA) are considering regulations or sponsoring research. Existing U.K. flammability regulations are largely based on the British standard BS 5852, which contains various tests and performance requirements regarding both open flame and cigarette ignitability.

An International Standard based on the small open flame provisions of BS 5852 was published in 1988 by the Organization for International Standards (ISO) as ISO 8191-2; a similar proposed European Standard was published in 1993 by the European Committee for Standardization (CEN) as prEN 1021-2. Separate cigarette ignition standards, ISO 8191-1 and EN 1021-1, also exist. These standards are voluntary; neither the ISO standards nor the CEN standards have been adopted as mandatory regulations. The CEN test methods were, however, referenced in a draft European Commission (EC) Directive, which would be mandatory in all EU member nations if promulgated (no action is imminent on this draft Directive). The French government recently announced its intention to develop a possible regulation, but did not state the target risk or technical basis for any such regulation.

The General Agreement on Tariffs and Trade (GATT) calls for signing nations generally to avoid imposing unreasonable barriers to trade. The part of the Trade Agreements Act of 1979 dealing with standards (19 CFR 2531), in implementing U.S. policy pursuant to the GATT, requires federal agencies to consider international standards and, if appropriate, base U.S. rules on such international standards.

The staff concluded from its evaluation of existing standards that the general approach and performance test methodology of the British, ISO and CEN standards would most reliably measure the small open flame performance of upholstered furniture, and would most effectively address the risk. The approach and test method of the draft CPSC standard are similar to those in the international specifications; some provisions are virtually identical. Thus, any CPSC standard would, if adopted, be in substantial harmony with known international standards.

F. Analysis of ANPR & Other Comments

The Commission's June 1994 ANPR presented available small open flame hazard data and preliminary technical and economic information, requested offers to develop a standard, listed some possible regulatory alternatives, and solicited public comments. In response, the agency received 58 comments. These comments discussed the hazard data, testing and technical standards development issues, economic concerns, and other potential risks such as potential FR chemical toxicity. Thirty-three of the comments generally supported a mandatory small open flame rule for upholstered furniture; 25 opposed a rule or identified alternatives. The public comments in response to the ANPR are maintained in the CPSC Office of the Secretary as file #CF 94-1.

The staff has communicated with various outside parties, including several of the commenters as well as individual manufacturers and other knowledgeable organizations, since the ANPR was published. The staff met with a number of groups having technical expertise on specific topics, most notably laboratory test methodology and related issues. A number of additional written comments and suggestions were received as a result of these outreach activities. These additional comments were considered along with the ANPR comments.

The staff adopted many of the commenters' suggestions in developing the draft standard. The staff's analysis of the public comments is summarized in the discussion below. Staff memos responding to individual comments appear at Tab J.

1. Issue: Fire Hazard Data

Fourteen commenters either provided, questioned or requested fire data relevant to the risk to consumers of open flame ignited

furniture fires. Two fire safety organizations provided statistics on small open flame sources. Six industry representative groups noted the need for specific small open flame data and for details on ignition scenarios and mechanisms to support CPSC action. Four commenters discussed the potential effect of a possible rule on small open flame fires in which upholstered furniture was not the first item ignited: one industry association cautioned against overstating the addressable hazard; three safety organizations opined that the addressable hazard may be understated. Three commenters discussed the impact of the Commission's recent lighter rule on childplay furniture fires; two of these stated that the lighter rule could significantly reduce the need for an upholstered furniture standard. Finally, four industry associations, in discussing the scope of a possible CPSC rule, stated that the available fire data do not support the inclusion of specific product categories (i.e., futons) or products intended for various residential occupancies (i.e., hotels and motels).

Response: The national fire data, along with subsequent calculated estimates for the most recent data years, describe the nature and extent of the small open flame ignition hazard. The staff considers the national estimates approach of quantifying these fire losses to be a reliable basis for the Commission's hazard analysis. NFPA data and CPSC staff estimates provide a breakdown of fires ignited by matches, lighters and candles--"small" open flame sources--compared to other open flame ignited fires. The data indicate that a substantial majority of all open flame upholstered furniture fires involve these small flame sources. As shown in Table 1 (p. 7), for the most recent 5 year period (1990-94), small open flame losses accounted for about 80% of all open flame furniture fire losses, including about 100 deaths, 460 injuries, and $46 million in property damage.

The staff agrees with the view expressed by numerous commenters that more details than are available from the national fire data are needed to characterize ignition scenarios and mechanisms. To supplement the national statistics, the staff conducted a two year study of open flame furniture fires. CPSC investigators conducted in-depth investigations of 76 fires determined to be small open flame related. The study provided data on types of ignition sources, circumstances and locations of ignitions, kinds of furniture products involved, and other information that helps characterize the risk to consumers.

The most often reported ignition scenario involved children igniting seating area surfaces while playing with lighters or, less frequently, matches. In most of the rest of the cases, tipped candles (not childplay) caused the fire. The study findings, while not based on a statistically representative sample of fire incidents, suggest that an effective standard should address these fire scenarios.

The staff recognizes that the CPSC lighter rule, which became effective in July 1994, is expected to prevent some of the fire losses included in the national small open flame estimates. Lighter childplay fire deaths do not, however, constitute a majority of all small open flame upholstered furniture fire deaths. For 1990-1994, an estimated 40 of the 100 small open flame furniture fire deaths resulted from childplay lighter fires involving upholstered furniture ignitions. Most but not all of these involved fires started by children under five. Further, not all fires started by children under five would have been prevented; the best estimate of the expected number prevented is about 25. Thus, an average of about 75 deaths per year involving matches, candles and non-childplay lighter fires would not have been addressed by the lighter rule. This indicates that the lighter rule alone would not substantially reduce the risk from small open flame ignited furniture fires.

The staff also agrees with commenters suggesting that a standard may have a beneficial impact on some open flame fires not classified as ignited by small flame sources. The extent of any such benefit, however, is uncertain, and likely to be small in view of the relatively low number of deaths and injuries attributed to larger open flame ignitions. To the extent that these other fires may be prevented by product changes aimed at reducing small open flame ignitability, the national fire data may yield conservative estimates of the potential benefits of actions to reduce small open flame ignited fire losses.

2. Issue: Basis for Standard

Thirteen commenters submitted technical recommendations or criticisms regarding the development of a standard. Ten commenters, including the original petitioner, provided information in support of or in opposition to the petitioner's request to adopt California TB-117 as a mandatory standard. Two organizations specifically discussed component vs. composite tests found in the California and U.K. regulations. One foreign government organization suggested test method alternatives. Two commenters discussed the suitability of adopting the U.K. regulations. Three industry groups questioned the relation of CPSC's regulatory proceeding to the available risk data. Four industry associations raised issues on the relative impact of a standard on small open flame ignited fires and cigarette ignited fires, and cautioned against reducing the small open flame risk at the expense of worsening the cigarette risk.

Response: California TB-117 requires that component materials resist small open flame ignition. TB-117 is, however, a "minimum" standard that would not, if federally mandated, ensure a substantial reduction in the risk of small open flame ignition of finished articles of furniture. The cover fabric test in TB-117, for example, incorporates a 1 second surface exposure to a

very small flame; this test, in CPSC's apparel regulations, is based on the 1953 Department of Commerce standard, CS 191-53; virtually all modern upholstery cover fabrics pass this test.

Laboratory testing demonstrated that component materials' ignition performance may differ from that of composite materials. In CPSC's tests, the component tests in TB-117 did not satisfactorily predict composite ignition behavior. Fabrics and fillings that comply with TB-117 often ignited when tested as finished chairs. The presence of FR fillings in California chairs may have limited combustion in some cases, but did not appreciably delay fabric ignition or curtail surface flame spread.

The draft standard developed by the staff uses a seating area mockup test with a larger and longer duration flame than TB-117, and limits sustained combustion of cover materials. The flammability of filling materials is not tested. The CPSC staff's test more reliably evaluates the contribution of fabrics, the primary determinant of full scale ignition performance.

The International Activities section notes that the CPSC draft standard test method is very similar to that in two existing international standards, EN 1021-2 and ISO 8191-2. Both are ignition tests incorporating a 35mm butane flame as in the British standard BS 5852, and using similar composite mockups. Thus, the staff's draft standard is conceptually consistent with the approach being considered in other nations regulating or contemplating regulation of upholstered furniture products.

The staff evaluated the small open flame test methods in both TB-117 and BS 5852, and found the British standard's mockup test to be more indicative of full scale performance. The staff concludes that the British approach is probably more effective at reducing small open flame ignited fires. The staff agrees with some commenters' statements that the technology to meet the requirements of the U.K. regulations is available and feasible. While one commenter recommended that the Commission require the use of FR "combustion modified" foams such as those used in the U.K. (and usually containing melamine as a flame retardant, which is not generally used in the U.S.), the staff considers performance requirements adequate to address the risk, and does not consider it necessary to require FR foams or any other specific FR upholstery materials. Other approaches may be suitable to meet a small open flame performance standard, including barrier materials as well as FR upholstery fabrics.

The staff concurs with the concern expressed by several commenters that the relatively short, intense assault of a small open flame and the slow smoldering characteristic of cigarette ignition are two different phenomena. Product improvements made over the years, such as the increased use of thermoplastic

upholstery cover fabrics, greatly reduced the cigarette ignition propensity of upholstered furniture, with the undesirable side effect of potentially poorer open flame behavior.

The staff also agrees that a small open flame standard should not encourage product modifications that would weaken cigarette ignition resistance, but does not agree with the implication that the use of small open flame resistant materials to meet a CPSC rule would necessarily worsen smoldering ignition performance. While some existing upholstery cover materials, including a number of heavyweight cellulosics, may ignite relatively slowly from small open flames but not resist ignition from smoldering cigarettes, the use of such materials is minimized by specifying a 20 second flame exposure time in the draft standard. Several heavyweight, 100% cellulosic fabrics were tested in accordance with the draft standard test method; all but two ignited from a 20 second flame exposure and continued to burn, and would thus not meet the requirements of the draft standard.

Further evidence that small open flame performance may be improved without compromising cigarette ignitability comes from CPSC's laboratory experiments. Most FR backcoated fabrics that performed well in small open flame tests also were cigarette ignition resistant, including 100% cellulosic and cellulosic/ thermoplastic blend fabrics that would otherwise be susceptible to cigarette ignition. Although the tests were limited to the available treated fabrics, the results suggest that FR technology applied to reducing small open flame fire losses would also reduce cigarette fire losses; indeed, FR fabrics have been examined previously by industry as a possible approach to reducing cigarette ignitability.

Another approach involves the use of "intumescent" FR barriers, placed between the cover fabric and filling material, that swell when ignited and cause cover fabrics to self-extinguish. Some such barriers tested by CPSC performed well in both small open flame and cigarette ignition tests.

3. Issue: Laboratory Testing

In addition to the comments received directly in response to the ANPR, seven industry organizations provided constructive criticisms and suggestions regarding CPSC's laboratory testing activities, such as test procedures and results. Topics included potential provisions for sample conditioning, test room requirements, test flame size, configuration and exposure time, test mockup configuration, performance measurement criteria, and equipment and instrumentation specifications and operation.

Response: The staff incorporated a number of the commenters' suggestions into the draft standard test procedure:

a. Sample and room conditioning suggestions for differing temperature and humidity conditions were accommodated by specifying allowable ranges; the staff determined that conditions within these ranges would not significantly affect test results.

b. The specified butane flame, controlled for both height (35mm) and flow rate (using a calibrated flow meter system), is consistent with several commenters' recommendations, as is the general approach of testing for ignition and progressive combustion of materials in composite mockups; to characterize the test flame, the staff used a heat flux gauge, as suggested by one commenter, to describe the heat energy output at different points along the axis of the flame so as to ensure accurate flame positioning. The staff also used thermocouples to characterize the test flame temperature profile.

c. The test fixture was redesigned after critical comments were received, to: allow for more convenient and less frequent fixture and sample adjustments; reduce the overall size of the equipment, without reducing test specimen dimensions, to fit into typical chemical hoods; use modular components so that multiple tests could be run at once, thereby reducing costs; improve the accuracy of test flame positioning; increase the air space between the test flame and its shield, to minimize flame instability; and reconfigure the mockup to resemble an industry developed model that eliminates gaps between specimen sections.

d. The test fixture operation manual was also revised to provide more troubleshooting information, and to give instructions on alleviating burner clogging.

e. The skirt test was deleted from the test method regimen.

The staff rejected some of the commenters' suggestions for laboratory test method or procedure modifications after reviewing available hazard and technical information or after conducting laboratory experiments:

a. The test method continues to specify carbon dioxide (CO_2) extinguishment of burning test specimens because this method is more effective, convenient and economical than water extinguishment, and because the use of water would not allow for multiple tests at different locations on a given test specimen.

b. The seating area test flame impingement location was kept at the seat/back juncture, rather than moved to a suggested point on the horizontal seating surface; this location is a reasonably foreseeable one in childplay and tipped candle fires, and presents the most severe test of ignition performance among possible seating area locations.

c. A 10 minute leeway in sample transport time (i.e., between conditioning room and test room) was considered not to be excessive, as one commenter contended, since only extreme conditions could influence sample moisture content in less time.

d. Contrary to the theory of one commenter that FR fabrics would not form a sufficient char to prevent filling material ignition, CPSC laboratory tests identified some FR fabrics that quickly self-extinguished and produced enough char to protect filling materials underneath; this tends to confirm that FR fabric technology can be applied and can be measured by CPSC's tests.

e. A 20 second flame exposure time was retained; a recommended 12 second time that would allow more fabrics to comply was rejected; laboratory tests show that a 12 second time does not adequately discriminate between materials that ignite and continue to burn (sometimes rapidly) from small open flame exposure, and materials that resist ignition or self-extinguish; further, 20 seconds represents a conservative measure of expected lighter or candle exposure, and represents typical observed match exposure times.

f. Automatic test flame positioning, characterized as unnecessary by one commenter, was retained as a feature of the CPSC test apparatus to ensure consistency of flame delivery, a critical factor in obtaining reliable results; although some testers may be able to achieve sufficiently precise placement manually, CPSC's tests would be conducted using the automatic positioning.

g. A test-specific dust cover clamp system, as requested by one commenter to maintain a flat, taut specimen could be designed but was not incorporated into the draft standard test method. CPSC's laboratory experience is that a reasonably flat and taut specimen can be maintained in the sample holder by clamping the specimen manually; the time needed to accomplish this is only a few seconds. A more complicated clamp system would probably have little effect on test reproducibility or repeatability.

h. A suggestion to measure three levels of observed performance (e.g., in an interlaboratory evaluation) could be adopted but is not appropriate for a pass/fail criterion in a standard; the performance provisions in the draft CPSC standard adequately take into account gradations of ignition performance by requiring only that tested materials either not ignite or self-extinguish within 2 minutes after removal of the test flame.

4. Issue: Economic Impacts

Thirteen commenters provided views and information on various issues affecting the potential benefits, costs and other economic effects of a standard. Four commenters discussed benefits and costs associated with California TB-117, in support of adopting that standard. Four trade organizations discussed the British

approach as an alternative to TB-117. Three groups suggested that the benefits of a standard may be understated by the small open flame fire loss data. Four industry associations stated that the potential benefits of a small open flame standard may be offset by increases in cigarette ignitability. Three commenters discussed the impact of CPSC's lighter rule on the likely benefits of an upholstered furniture standard. Five commenters discussed the cost reduction potential of voluntary alternatives. Two futon industry associations opposed including futons within the scope of a proposed rule. Three other organizations offered additional information about the potential costs of a standard.

Response: The staff agrees that adopting TB-117's small open flame component requirements would substantially lower the estimated cost of a standard, and could minimize industry disruption. Increased manufacturing costs would be on the order of $5-10 per unit to incorporate well-known FR foam technology. The total impact on annual retail consumer expenditures outside of California is estimated at about $250 million. CPSC's laboratory tests, however, suggest that little reduction in the societal cost of small open flame fire losses would accompany such a standard. The staff concludes that adopting the small open flame requirements of TB-117 as a national standard may not be cost effective.

Adopting the major elements of the British standard approach imposes higher costs but confers substantially higher potential benefits upon consumers. The mockup approach of BS 5852 is reasonably predictive of full scale results; laboratory tests show that greatly improved small open flame ignition performance can be achieved under this approach with readily available, feasible technology. Furthermore, preliminary testing suggests that this technology may reduce, rather than increase, cigarette ignitability. The draft standard developed by the staff is very similar to the basic provisions of BS 5852. While the estimated annual cost of the staff's draft standard could exceed $700 million, reasonable expected small open flame fire loss reductions coupled with modest cigarette fire loss reductions would yield expected benefits at least equal to the likely cost.

The staff agrees that some open flame ignited upholstered furniture fires involving other than small open flame sources could be avoided if products were small open flame resistant. The extent to which this may occur is uncertain, however; since most open flame fire losses involve small flame sources, any understatement of benefits would probably be small. Potential reductions in other open flame ignited fires are not taken into account in the estimation of benefits of the draft standard. As noted above, however, significant reductions in cigarette ignited fire losses may accompany a small open flame standard; these potential savings constitute a substantial part of the overall expected benefits.

The Economic Considerations section notes that although the CPSC lighter rule is expected to reduce small open flame fire losses, not all of these losses would be eliminated. About 75 of the 100 total small open flame related deaths (and about $470 million in annual average societal costs) would remain unaddressed. The baseline for estimating benefits associated with a small open flame standard reflects a $150 million downward adjustment to account for the effect of safer lighters.

Additional information on the likely costs associated with a small open flame standard was submitted by several commenters. The staff used this and other information on the increased cost of FR treated materials in estimating the anticipated cost of the draft CPSC standard to industry and the public. One commenter stated that a standard could limit consumer choice, particularly among non-smoking households; however, although about 70 percent of households are non-smoking, a 1990 CPSC household survey on lighter and match usage found that nearly 90 percent of all households have matches and lighters. Therefore, while there may be greater potential exposure in smoking households, the small open flame risk is not limited to smoking households.

5. Issue: Potential FR Chemical Toxicity

Four commenters discussed the potential toxicity of FR chemicals that could be used in upholstered furniture to comply with a small open flame standard. Two European government organizations expressed concern that the use of products containing FR chemicals may present a toxic hazard, and cited a report prepared for the European Commission (EC) on this topic; a chemical industry association, citing the same report, stated that such chemicals would not pose health hazards. One commenter (the petitioner) characterized the smoke produced by burning FR treated materials as less toxic than that of non-FR materials, citing a NIST study on FR chemical combustion toxicity.

Response: The EC report notes that some FR chemicals may be toxic. Certain FR chemicals are mutagens or carcinogens, exhibit delayed neurotoxicity, or have other effects. "Toxic" substances are defined in the FHSA as "hazardous" if they can, due to reasonably foreseeable handling and use, cause illness or injury. The toxicity and bioavailability of the full range of FR treatments that may be used in upholstered furniture to meet a standard is uncertain, though it is estimated to be low for a number of chemicals the staff has reviewed. CPSC laboratory chemical extraction tests on fabrics containing antimony trioxide or organophosphates revealed no measurable FR chemical release under expected conditions of normal use or cleaning. The EC report's exposure assessment for FR fabrics provides no conclusive evidence about the likely rate, if any, of FR chemical release or bioavailability, or of possible consumer exposure. The staff is, however, concerned about the use of any toxic

chemicals; before proposing any regulation that would lead to their use, the potential toxic hazard associated with such chemicals should be carefully evaluated.

The NIST study of combustion toxicity identified no highly toxic compounds in the smoke produced by FR chemicals. Although burning upholstery materials contain toxic combustion products, there is no evidence that the smoke toxicity of FR treated fabrics is appreciably greater than for untreated fabrics.

6. Issue: Alternatives

Eight commenters presented views on alternatives identified in the ANPR. Four commenters gave different opinions on the prospects for and technical adequacy of voluntary standards to address small open flame ignited furniture fires. Four other groups commented on labeling or information and education efforts.

Response: No existing U.S. voluntary standard addresses the risk of small open flame ignited upholstered furniture fires. The staff has communicated with industry representatives (like UFAC) and with voluntary standards organizations (like NFPA and ASTM) to discuss possible voluntary alternatives to a proposed CPSC rule. In 1996, ASTM established a work group, comprised of members of its E-5.15 Subcommittee on Furnishings and Contents Flammability, to investigate the need for a small open flame standard, and to develop an appropriate test method if necessary.

The CPSC staff's view is that a technically adequate voluntary standard should incorporate a reasonably reliable test method and should be effective in reducing projected small open flame fire losses. The technical work on the CPSC staff's draft standard may provide a basis for such a voluntary standard. While the staff agrees that voluntary action could yield a reasonable alternative to CPSC regulation, no such voluntary measures have yet been established, and available FR materials are not now used in furniture that could be made safer by use of such materials.

UFAC considered incorporating the small open flame provisions of TB-117 into the UFAC Voluntary Action Program; the group sponsored tests in 1995 to evaluate the need for such action. UFAC concluded that adopting TB-117 would not appreciably improve small open flame ignition resistance, and that no action was warranted, but that the industry would continue to work with CPSC toward possible voluntary improvements.

Although labeling or information and education are possible alternatives to a product performance standard, the staff notes that warning labels and information and education campaigns would likely have much less of an impact on fires, deaths and injuries than passive measures that do not rely on behavior modification.

Labels could not be expected to be read by children, the population group most likely to be involved in small open flame ignited fires. Similarly, while information and education programs can be helpful generally, they typically reach less than half the target audience and do not usually result in widespread changes in consumer behavior. The staff concludes that a flammability standard would have a significantly greater impact on small open flame fire losses than would either labeling or information and education.

7. Other Issues

Twenty-two state and local fire officials submitted comments in general support of a small open flame standard to protect the public. Thirteen furniture retailers opposed a standard, and generally expressed the view that the voluntary UFAC program adequately addressed upholstered furniture flammability. These supporting and opposing commenters provided no substantive data to support their positions.

Some of those in opposition to furniture regulation suggested cigarette fire safety regulation instead. Since the expiration of the Cigarette Safety Act of 1984 and the Fire Safe Cigarette Act of 1990, which granted authority to CPSC to investigate the ignition propensity of cigarettes, no Federal government agency has jurisdiction over tobacco products in the area of fire safety.

Two state government fire safety organizations commented on potential enforcement problems associated with upholstered furniture flammability regulations. One state group recommended a national mandatory standard to reduce enforcement burdens on states that might consider their own regulations. The California BHF, which already enforces regulations in that state, opposed any rule that might be weaker than the existing California regulations, but that might pre-empt state rules. No CPSC determination has been made about the possible pre-emption of state rules. The CPSC staff's draft standard may be considered more stringent than TB-117 in terms of small open flame ignition. There is, however, a continuing need to provide cigarette ignition protection; TB-117 contains cigarette ignition requirements (similar to those in the UFAC voluntary guidelines) as well as small open flame requirements.

G. Conclusions

From the available information concerning small open flame ignited furniture fires, including recent hazard data, laboratory testing and other technical work, economic analysis of alternatives, and public comments, the staff concludes that:

- Deaths, injuries and property damage resulting from upholstered furniture fires ignited by small open flame sources (chiefly lighters, matches and candles) constitute a significant, continuing risk to the public; after factoring in the expected impact of the Commission's lighter rule, small open flame ignitions of upholstered furniture would still cost society an estimated $470 million annually; despite a decline in fires, the numbers of deaths and injuries have remained relatively stable.

- Evidence from fire investigations suggests that most small open flame ignitions involve childplay with lighters and, to a lesser extent, matches; seating areas of furniture are the most likely ignition location; underside locations, i.e., dust covers, are probably less often involved; skirts are rarely identified as being specifically involved in ignition.

- Virtually all currently manufactured U.S. residential furniture ignites when exposed to small open flames for sufficiently long periods of time; most furniture does not resist ignition when exposed for short periods (generally varying between 5 and 20 seconds) to a small open flame source representing a match or lighter; some current materials, like leather, wool, and certain cotton and nylon fabrics, may perform significantly better than others, but products using these materials account for a relatively small share (roughly 20%) of the residential market.

- There is no nationwide voluntary or mandatory standard addressing this risk; the existing California regulation suggested by the petitioner does not adequately address the risk, since complying products still ignite and burn; the staff's draft standard, which uses the mockup test approach embodied in the existing U.K. regulation and in the fabric classification test of the UFAC voluntary guidelines, could effectively address the risk.

- Effective fire retardant technology is available for use in residential furniture materials; FR treated fabrics are widely used in the U.K.; certain FR barrier materials that cause burning fabrics to self-extinguish may also meet a performance standard; limited CPSC laboratory testing indicates that these approaches could greatly improve small open flame performance.

- Although the staff has identified a number of available FR fabric treatments that are either not toxic or not bioavailable, uncertainty exists about chronic risks that could be posed by certain FR treatments; more information is needed on potential consumer exposure to and bioavailability of FR chemicals from treated upholstery materials.

- While the relationship between open flame performance and cigarette ignitability of most conventional upholstery cover fabrics may be negative (i.e., improving one aspect could worsen the other), CPSC laboratory data and information from European testing suggest that FR cover materials could reduce both small open flame and cigarette ignitability; in CPSC laboratory mockup tests, FR materials resisted both small open flame and cigarette ignition or self-extinguished in almost all cases; the staff will continue to conduct laboratory tests to evaluate this potential effect.

- A small open flame standard may increase retail prices of upholstered furniture by an average of about $23-30 per item; the estimated total annual cost to the public is $460-720 million; the draft standard developed by the staff would probably not have significant or disproportional adverse impacts on small businesses.

- A standard may have substantial benefits to consumers, in the form of reductions in both small open flame and cigarette ignited fire losses; net benefits to consumers would accrue from a standard that is about 80% effective at reducing small open flame ignited fire losses and at least 20-30% effective at reducing cigarette ignited fire losses; the available laboratory testing evidence suggests that these levels of effectiveness are achievable, and that a standard could be more than 50% effective at reducing smoking material ignited fire losses; such a standard may have expected annual net benefits (i.e., after subtracting average estimated costs) of about $300 million.

V. Cigarette Ignition: Petition Evaluation

Since the Commission deferred action on the cigarette portion of the NASFM petition, the staff has conducted activities to evaluate the ignition performance and UFAC conformance of upholstered furniture. The staff surveyed upholstered furniture manufacturers, performed laboratory tests, analyzed economic issues and reviewed comments from outside organizations. These activities are summarized below.

A. Manufacturers Survey

CPSC sponsored a survey of upholstered furniture manufacturers in 1995. This survey sought information principally on the use of fabrics, filling materials and other components of upholstered furniture that could affect cigarette ignition resistance. A report on the analysis of the survey data appears as an appendix to the staff report at Tab K. The CPSC survey findings, along with CPSC's laboratory test results, provide the basis for evaluating the overall level of cigarette ignition resistance of upholstered furniture.

Survey respondents reported on their use of materials and constructions in items produced during the previous year. A total of 162 furniture manufacturing establishments, including 120 UFAC members (representing the vast majority of sales) and 42 non-UFAC members, responded to the survey. There were no statistically significant differences observed between UFAC and non-UFAC survey respondents, except that non-UFAC respondents used less heat-conducting welt cord in welted constructions. The survey data were used to estimate ignition resistance among pieces of upholstered furniture.

The survey found, as shown in Table 2, that about half of all currently made upholstered furniture is covered with predominantly thermoplastic materials, and that about two-thirds of current production is covered with materials likely to contribute to cigarette ignition resistance (i.e., thermoplastics plus wool, leather and vinyl). About one-third is covered with predominantly cellulosic fabrics; some of these also resist cigarette ignition when used with appropriate fillings or barriers.

The survey updates the information provided by previous (1981 and 1984) CPSC surveys used in the agency's earlier ignition propensity estimates. The 1995 survey shows increased use of predominantly non-cellulosic cover fabrics (especially leather) and of polyester fiberfill in contact with fabrics in seats, backs and inside arms of upholstered furniture. These materials

Table 2: Primary Upholstery Cover Fiber/Material Used in Upholstered Furniture Production (based on % of yardage, 1995)

Upholstery Cover Material	% of Production
Cellulosic	31
Thermoplastic	51
Wool or Leather	10
Vinyl-coated	5
Other	2

are generally more resistant to cigarette ignition than predominantly cellulosic fabrics and the filling materials previously found to be more widely used in direct contact with cover fabrics, e.g., cotton batting and urethane foam. Whether the apparent trend away from cellulosics will continue in the style-conscious residential furniture market is unpredictable.

The 1995 survey data, when combined with laboratory test results, supplement the information provided in a 1994 market survey report prepared for UFAC by Heiden Associates, Inc. The Heiden report concluded that UFAC's assertion, that 90% or more of the dollar value of upholstered furniture sold in the U.S. conformed to UFAC's voluntary guidelines, was reasonable.

B. Laboratory Testing

The staff conducted a cigarette ignition test program for currently-manufactured products. The staff purchased a total of 58 chairs--40 manufactured by UFAC participant firms plus 18 by non-UFAC firms--and tested them in accordance with the CPSC/NIST full scale protocol. The components used in the test chairs were also tested in accordance with the UFAC methods.

The test chairs comprised a variety of popular styles, materials and constructions selected to represent the range of products now available. Covering materials included all-cellulosic, all-thermoplastic, and various blended fabrics, as well as silk and leather. Four of the purchased chairs were labeled in compliance with California TB-117; usually, furniture components that pass the UFAC tests would also meet TB-117.

The full scale tests yield a basis for estimating cigarette ignition propensity. The component tests form the basis for estimates of overall industry UFAC conformance and of conformance among chairs from UFAC participating and non-participating manufacturers. The staff's detailed analysis of the test data appears at Tab K.

1. Cigarette Ignition Resistance: Full Scale Tests

Under the CPSC/NIST full scale protocol, up to 15 lit cigarettes were placed on each test chair, i.e., 3 cigarettes in each of 5 locations, including the seat cushion, seat/back crevice, seat/pillow crevice, seat/side crevice and welt cord, depending on the style of the chair (not all chairs have backs, sides, pillows or welt cords). Char length greater than 3 inches or progression to an obvious ignition from any one cigarette constituted an ignition of the chair.

Another way to assess ignition resistance is to count the number of cigarettes that cause ignitions on seating area locations (where a dropped cigarette is most likely to fall) of each test chair. This approach, which is favored by industry representatives, illustrates differences between chairs that ignite from a small number of cigarettes and chairs that have many ignitions in the test.

Analysis of the full scale chair test data in light of the CPSC manufacturers survey data yielded overall estimates of cigarette ignition resistance. Table 3 shows these estimates broken down by cover fabric type, the primary factor affecting the ignitability of currently manufactured furniture. Estimates are also presented for a) ignitions of individual chairs and b) ignitions by individual cigarettes. These two measurement approaches yield slightly differing results.

a) Ignitions of Chairs

All (100%) of the predominantly thermoplastic (e.g., polypropylene, polyester, nylon) fabric- and leather-covered chairs resisted ignition in the full scale tests. The 100% cellulosic (e.g., cotton, rayon) and blended fiber fabric-covered chairs exhibited mixed results: ignition resistance increased with thermoplastic content; other factors, including fabric weight and construction, also affect ignition resistance.

Based on the test results and survey data for UFAC chairs and manufacturers, approximately 83% of UFAC furniture now available to consumers would resist cigarette ignition. This overall estimate, while subject to some variability, reasonably illustrates the state of currently produced furniture.

The test results suggest that virtually all current, 100% thermoplastic fabric-covered items would resist ignition. Predominantly cellulosic fabric-covered items would be less ignition resistant, depending on their thermoplastic content, weight and construction. Including test results for non-UFAC chairs does not change these estimates.

Table 3: Cigarette Ignition Resistance of Currently Manufactured Upholstered Furniture (% Resisting Ignition in 1995 CPSC Full Scale Tests by Fabric Type and Measurement Approach)

	% Non-ignition of Chairs	% Non-ignition by Individual Cigarettes
Estimated Total	83	92
Predominantly Thermoplastics	100	100
Lightweight Predominantly Cellulosic	56	91
Heavyweight Predominantly Cellulosic	43	61

Note: Estimated total ignition resistance based on 1995 CPSC full scale test results weighted by 1995 CPSC manufacturers survey data on cellulosic fabric usage.

The 1995 ignitability estimates suggest a continuing improvement in observed levels of cigarette ignition resistance. CPSC tests in 1980 and 1984, using the same test procedure as in 1995, indicated that about 50% and 68%, respectively, of UFAC furniture would resist ignition.

b) Ignitions by Cigarettes

All of the 100% thermoplastic fabric-covered chairs resisted ignition in the full scale tests; this means that all of the cigarettes placed on these chairs burned their entire length without causing ignitions. Nearly all of the chairs covered with predominantly cellulosic fabrics that ignited in the full scale tests had one or more test cigarettes that did not result in ignition. Thus, counting cigarettes instead of chairs yields somewhat higher estimates of ignition resistance.

Based on proportions observed in the test and survey data for UFAC chairs and manufacturers, about 92% of cigarettes dropped on such products probably would not cause ignition, as noted in Table 3. The 92% level represents a nominal improvement over previously observed levels of 78% in 1980 and 87% in 1984.

2. UFAC Conformance: Component Tests

The UFAC guidelines include a number of tests for cigarette ignition resistance of upholstered furniture components. The use of conforming components increases the likelihood that assembled

articles of furniture will resist cigarette ignition. Table 4 presents the results of CPSC's tests of components taken from the 58 full scale test chairs; the table also describes full scale ignition resistance as a function of UFAC conformance among tested chairs. As the data illustrate, UFAC conformance is high, even among non-UFAC participants. The CPSC laboratory test results generally support UFAC's 90% conformance claim.

Table 4: Conformance to UFAC Guidelines of Currently Manufactured Upholstered Furniture (Chairs Conforming and Resisting Ignition in 1995 CPSC Tests, by Manufacturer Participation Status)

Mfr. Status	UFAC Conformance	% Resisting Full Scale Ignition: (Conforming)	(Non-conforming)
Total, all chairs (n=58)	86% (50/58)	66% (33/50)	75% (6/8)
UFAC participants (n=40)	93% (37/40)	68% (25/37)	100% (3/3)
Non-UFAC participants (n=18)	72% (13/18)	62% (8/13)	60% (3/5)

Note: Conforming chairs passed all UFAC component tests; chairs resisting ignition did so in full scale tests of finished items. Chairs tested were selected to represent range of available cover fabrics, and do not reflect the market shares of those fabrics.

Most, but not all, chairs whose components passed the UFAC tests also resisted ignition in the full scale tests. The table shows, for example, that although 93%--37 out of 40--of the chairs manufactured by UFAC participants passed the UFAC component tests, only 68%--25 out of 37--of these conforming chairs were ignition resistant in CPSC's full scale tests; the remaining 12 conforming chairs ignited from at least one cigarette. Most non-conforming chairs were also ignition resistant in full scale tests (although the sample sizes are small; there were only 8 non-conforming chairs among the 58 tested). Overall, chairs from UFAC participant manufacturers were somewhat more ignition resistant than non-UFAC participants' chairs in full scale tests, irrespective of UFAC guideline conformance. UFAC conformance is, however, only a rough indicator of full scale cigarette ignition resistance.

Concern over the predictive capability of component tests, such as those in the UFAC program and in California TB-117, has long been an issue among standards-writing bodies. The estimates of UFAC conformance and ignitability illustrate that cigarette

ignition resistance is primarily dependent on combinations of materials used in actual furniture. Individual component materials may perform differently when assembled into finished items. Further, there is little evidence that materials selection is influenced by the manufacturers' participation in the voluntary program; participants and non-participants generally purchase the same kinds of components and materials, reflecting materials prices and availability, and consumer preferences for different styles, fabrics and other features.

C. Economic Issues

A cigarette ignition standard may have substantial economic effects, in terms of both benefits to the public and costs to industry and consumers. A review of issues regarding potential benefits and costs of a cigarette ignition standard appears at Tab L.

Upholstered furniture is found in virtually every household. As noted in the economic data discussion of Section IV-D, consumers purchase 25-30 million pieces annually. These are often long term choices: the average life of upholstered furniture is about 14 years, which means that many pieces are in service for 20-30 years or more.

Estimated hazard costs associated with smoking material ignited upholstered furniture fires in 1994 (the latest fire data year) were about $2.3 billion. If all furniture in household use were made with the kinds of cigarette ignition resistant materials found in the 1995 survey of production, expected societal costs of cigarette ignited fires would be about $1.7-1.8 billion, or about $0.5 billion lower than the overall 1994 estimate. Assuming furniture in use will gradually tend to be more like current production, this lower estimate approximates the maximum annual level of future benefits from actions addressing upholstered furniture fires ignited by smoking materials.

CPSC and other laboratory test data suggest that the societal cost of smoking material ignited fires is largely attributable to predominantly cellulosic fabric-covered furniture. Expected hazard costs over these products' expected life are about $140 per item, compared to an average of about $4 per item for all other upholstery cover materials. Thus, for predominantly cellulosic fabric-covered articles, a standard that substantially reduces or eliminates the risk but adds less than $140 to the average unit price may be cost-effective. Potential benefits may also be affected by actions to reduce small open flame ignitions.

A standard addressing only cigarette ignition resistance, either similar to the 1976 CPSC/NIST draft (which incorporated a composite mockup test) or like California TB-116 (which

incorporated a full scale mockup test), may result in further shifts away from relatively ignitable fabrics like certain heavyweight cottons and other cellulosics. Consumers may have reduced fabric choices as a result, and there may be adverse economic impacts on certain segments of the textiles industry that rely on sales of cellulosic fabric. FR chemical treatments may be an option for some such fabrics, although this approach would increase manufacturing costs and could adversely affect durability and aesthetics.

Mandating the cigarette ignition performance requirements of TB-117 would likely have little impact on consumer safety or on the upholstered furniture market. The test for cover fabrics in TB-117, using a standard, untreated polyurethane foam, is similar to the UFAC cigarette test method; a number of ignitable fabrics are acceptable when used with an approved barrier. TB-117's smoldering test for resilient filling materials, using a standard cover fabric, is also similar to the UFAC test method for filling materials; untreated polyurethane foam and several other conventional filling materials pass this test.

A standard may impose testing and certification (e.g., labeling, recordkeeping, and reporting) costs upon manufacturers. The staff estimated such costs based on provisions in the 1976 CPSC/NBS draft standard; the yearly total, in 1996 dollars, would be roughly $30 million; the annual impact at the retail level could be about $75 million. The estimated cost, if allocated over all current upholstered furniture production, could average approximately $3-4 per unit. The staff would seek ways to minimize these costs in any new standard.

Of the 1,500-2,000 manufacturers and importers marketing upholstered furniture in the U.S., about 260 companies reportedly participate in the UFAC Voluntary Action Program. The industry features hundreds of small manufacturing establishments. Testing and certification costs could be disproportionate among small manufacturers without ready access to testing facilities or without existing recordkeeping systems. Many small firms also produce or specialize in small volumes of furniture with upholstery cover fabrics supplied by their customers ("Customer's Own Materials," or COM orders); these firms may also be affected disproportionately.

D. Potential Effects of an Open Flame Standard on Cigarette Ignition Resistance

The discussion in Section IV on small open flame standards development notes that FR fabrics or barriers used to meet small open flame performance requirements would probably also reduce cigarette ignitability. While it is possible that some small open flame related product improvements (such as the use of certain heavyweight, untreated cotton fabrics) could worsen

cigarette ignitability, CPSC's laboratory tests identified only one such untreated fabric that could meet the requirements in the staff's draft standard and that did not resist cigarette ignition in a typical construction (there was also one technical failure of a treated fabric). All of the seven other tested fabrics with acceptable small open flame performance were also cigarette ignition resistant in CPSC mockup or UFAC component tests.

Conversely, improvements in the general level of cigarette ignition resistance would likely result from further increases in the use of thermoplastics in upholstery cover fabrics, but would likely have little beneficial impact on small open flame ignition performance. CPSC mockup tests identified only one conventional thermoplastic fabric that resisted small open flame ignition for more than 20 seconds.

The potential benefits of CPSC action on the cigarette ignition risk are, therefore, dependent on the result of actions taken to reduce small open flame ignitions. If a small open flame standard substantially reduced cigarette ignited fire losses, additional requirements for cigarette ignition resistance may have little or no additional safety benefit.

E. Comments From Outside Organizations

The NASFM petition generated interest from a number of interested parties, including Congressional representatives, fire safety organizations, industry representatives, and other government agencies. Arguments supporting and opposing Commission action on cigarette ignited upholstered furniture fires have been advanced, both in response to the 1994 small open flame ANPR and in subsequent correspondence and meetings.

The petitioner, NASFM, stated a concern that the voluntary UFAC program may not adequately address the risk, primarily due to alleged technical shortcomings inherent in the UFAC component certification approach and to uncertain conformance, especially among producers of the lowest priced furniture. To support the latter point, NASFM sponsored a 1995 study of "discount" furniture retailers. NASFM concluded from this study that: 1) low-income consumers have insufficient access to information about less ignition-prone upholstered furniture and to purchasing options (such as UFAC-certified products) at retail stores; and 2) retailers are largely unaware of the UFAC program. NASFM's position is that this lack of knowledge on the part of consumers and retailers essentially puts low-income households at greater risk. NASFM shared their findings with CPSC and with UFAC. UFAC responded by providing information on its efforts to increase sales of safer furniture and to reach low-income and other vulnerable groups with fire safety messages.

The American Furniture Manufacturers Association (AFMA) and UFAC provided information and met with CPSC in order to advance their position that the UFAC Voluntary Action Program adequately addresses the cigarette ignition risk. They pointed to the dramatic decline in fire losses, largely made up of smoking fire death reductions, and cite the UFAC program as a contributor. They also pointed to the Heiden Associates survey results as evidence that the UFAC program enjoys substantial voluntary conformance. UFAC concluded that CPSC intervention is unneeded.

Other industry associations, including the American Fiber Manufacturers Association, the Polyurethane Foam Association, the National Cotton Council, the American Textile Manufacturers Institute, and the National Cotton Batting Institute, joined in support of the UFAC voluntary program as the best way to address the smoking fire hazard, and opposed new regulation. Most of these groups also stated their support for measures to reduce the ignition propensity of cigarettes, the principal ignition source for such fires.

The California BHF worked with the CPSC staff over a number of years to study upholstered furniture flammability, and provided technical comments and advice to the staff. Since TB-117 contains cigarette ignition resistance test requirements similar to UFAC's, components passing the UFAC criteria usually comply with TB-117. While supporting the Commission's work generally, BHF is concerned about possible pre-emption of TB-117 by a federal rule. BHF may seek exemption from pre-emption if any final CPSC rule (for either cigarette or small open flame ignition; TB-117 addresses both) were viewed as less stringent or otherwise incompatible with existing California law.

The Canadian government has also followed CPSC's upholstered furniture activities for several years, and has provided technical comments and advice to the staff. Health Canada sponsored an evaluation study, published in 1994, of the Canadian UFAC program. That evaluation was generally favorable, reporting estimated conformance of about 90% among upholstered furniture items sold in Canada, although the report expressed concern about non-conforming imports from the U.S.

The European Commission (EC) stated that it considered minimum requirements necessary for both cigarette and open flame ignition. It recommended that CPSC consider provisions of United Kingdom regulations as a possible model, but did not imply that such requirements should necessarily be mandatory.

F. Conclusions

From the available information concerning smoking material ignited furniture fires, including recent CPSC hazard and economic data and laboratory studies, the staff concludes that:

- Deaths, injuries and property damage resulting from upholstered furniture fires ignited by smoking materials (overwhelmingly cigarettes) constitute a major risk to the public; however, there has been a substantial death and injury reduction trend observed over recent years, probably due to a number of factors, including product changes (encouraged by the UFAC voluntary program) that make newer furniture safer on average than older furniture, reduced smoking, increased smoke detector usage, and improved medical care; this decline will likely continue and gradually stabilize as older, more ignitable furniture is replaced by newer, safer items.

- A substantial proportion--estimated at about 83%--of currently manufactured upholstered furniture resists ignition from smoldering cigarettes; the popularity of non-cellulosic (e.g., thermoplastic) fabrics is primarily responsible for the gradual improvement observed over time.

- A substantial proportion--about 86%--of currently manufactured upholstered furniture meets the UFAC voluntary cigarette ignition requirements (including products from non-UFAC participant firms); most components that pass the UFAC tests also resist ignition in finished pieces, but UFAC conformance does not ensure cigarette ignition resistance (or even passing UFAC test results in some cases); UFAC has no current plans to make further changes to its program.

- Since the estimated number of deaths is large, a performance standard having the effect of improving or eliminating readily ignitable materials could have substantial benefits over time; maximum potential benefits may be up to $1.7 billion per year for a highly effective standard.

- The likely cost of a standard to the public is estimated at under $100 million per year, or roughly $3-4 per item; the potential discontinuation or FR treatment of some predominantly cellulosic fabrics to meet a CPSC cigarette ignition standard represents a potential cost to consumers; testing and certification costs could be burdensome for small firms and firms serving the Customer's Own Materials market.

- Certain product technologies, such as FR fabrics or self-extinguishing barriers, can enhance both cigarette and small open flame ignition performance; for cigarette ignitability, FR treatments would be most effective in cellulosic fabrics.

VI. Options

The Commission has three basic options on each of the two upholstered furniture issues. With respect to the proceeding on small open flame ignition:

- If it preliminarily determines that small open flame ignited upholstered furniture fires present an unreasonable risk of death, injury or substantial property damage, the Commission may **issue an NPR**, containing a proposed performance standard and supporting information, in the Federal Register. Evidence that the hazard is significant and not declining, that the risk is addressable by the proposed rule, that the proposed rule is technically and economically feasible, that no existing voluntary action would adequately reduce the risk, and that the proposal may have net benefits to consumers may be used in support of this option. Comments could be solicited regarding the use of FR chemical treatments, and the potential cigarette ignition benefits of a small open flame rule.

- If it does not find sufficient evidence to propose a rule, the Commission may opt **not to issue an NPR** on small open flame ignited upholstered furniture fires. The Commission could conclude that the available data do not support agency action to reduce the risk, and **withdraw the ANPR.** Evidence that the small open flame risk is relatively small, that the expected benefits of reducing small open flame ignited fires do not justify the estimated cost, or that mandatory or voluntary action to address the cigarette ignition risk alone may be more in the public interest may be used to support this conclusion.

- Alternatively, if it concludes that more extensive review of the potential toxicity of FR fabric treatments is needed, or that other information is needed to support a decision, the Commission could **defer action** on the small open flame issue. Evidence that a small open flame standard may be necessary but that uncertainty exists about the relation between small open flame and cigarette ignition performance, and the potential of fabrics that meet small open flame requirements to resist cigarette ignition, may be used in support of this conclusion.

With respect to the NASFM request to initiate rulemaking addressing cigarette ignition:

- If it finds that cigarette ignited upholstered furniture fires may pose an unreasonable risk of death, injury or substantial property damage, the Commission may **grant** the petition and publish an ANPR in the Federal Register to start a regulatory development proceeding. Such a proceeding could be conducted

simultaneously with the ongoing small open flame initiative, and could solicit public comment on issues involving the interrelation of the two efforts. Evidence that the hazard, while declining, is large and could be addressed by a standard affecting a minority of currently available products, that a standard to improve cigarette ignition resistance may have safety benefits reasonably related to its costs, and that the existing UFAC voluntary program does not adequately reduce the risk posed by those products, may be used to support this option.

- If it does not find from the available evidence that cigarette ignited upholstered furniture fires may pose an unreasonable risk, the Commission may deny the petition and either terminate further investigation of the smoking fire risk, or direct the staff to continue to gather information that may lead the Commission to revisit the issue, e.g., when considering regulatory options regarding the small open flame risk. Evidence that the hazard has declined substantially and is expected to continue to decline without CPSC intervention, that the longstanding UFAC voluntary program will continue to contribute to the high general level of cigarette ignition resistance among currently available products, and that action to reduce cigarette ignitions could have effects that duplicate those of a small open flame standard, may be used to support this option.

- If it does not find the available evidence sufficient to determine whether cigarette ignited upholstered furniture fires may pose an unreasonable risk, the Commission may continue to defer action on the petition and direct the staff to gather additional information. Evidence that a small open flame standard might have overlapping, beneficial effects on cigarette ignition resistance may be used to support this option.

VII. Conclusions & Recommendations

Based on the available information, the staff concludes that a standard is technically feasible and could be highly effective at reducing the risk of residential upholstered furniture fires ignited by small open flame sources like lighters, matches and candles. To meet a small open flame performance standard, most cover fabrics would likely be treated with fire retardants, or be used in combination with self-extinguishing FR barriers.

The staff's analysis indicates that a small open flame standard could have substantial net benefits to consumers as a result of reductions in both small open flame and cigarette ignited fire losses. In preliminary tests, most FR treated fabrics provided small open flame protection; most of these also resisted cigarette ignition. The additional cigarette ignition benefits would accrue at no additional cost, and without imposing any cigarette ignition requirements.

The annual cost of a standard to consumers is estimated at about $460-720 million. Retail price increases may average about $23-30 per article of upholstered furniture. Based on CPSC laboratory test results of FR fabrics, the expected present value of annual small open flame societal benefits for an 80% effective standard would be about $255 million at current production levels. If at least 50% of cigarette fire losses were also averted, the expected present value of the additional yearly benefits would be about $570-690 million at current production levels. Potential total annual net benefits of such a standard are estimated at about $235-365 million. Using the midpoints of the various ranges of benefit and cost estimates yields estimated annual net benefits of about $300 million.

The staff continues to be prepared to participate with industry representatives in working toward a possible voluntary small open flame standard. The staff has encouraged the development of an effective voluntary standard that could be a reasonable alternative to a mandatory rule, and has developed a draft standard that could serve as a basis for further voluntary action.

The results of the staff's evaluation of the cigarette ignition propensity of currently manufactured upholstered furniture show continued improvement in the general levels of cigarette ignition resistance and industry conformance to the UFAC Voluntary Program. About 83% of chairs resisted cigarette ignition in the staff's full scale tests. The UFAC program calls for the use of ignition resistant component materials to reduce cigarette ignitability; in the staff's tests, about 86% of tested chairs conformed with the UFAC guidelines--roughly in line with UFAC's claim that about 90% of upholstered furniture conformed.

Products whose components met the UFAC criteria did not always resist cigarette ignition in full scale tests, however. Further, certain predominantly cellulosic fabrics continue to present a significant ignition risk. The staff concludes that, while the estimated levels of ignition resistance and UFAC conformance are both high, UFAC conformance does not necessarily assure cigarette ignition protection.

While the data gathered thus far demonstrate that a small open flame standard could have significant net benefits, some concerns remain about the use of FR fabric treatments. Some chemicals used in such treatments are known to be chronically toxic, although the staff knows of no evidence of likely consumer exposure. The staff recommends that, prior to considering a proposed small open flame standard, the agency gather additional information on the potential consumer exposure to and toxicity of FR chemicals that may be used to meet such a standard. Specifically, the staff recommends that CPSC sponsor a technical workshop to gather additional information on the toxicity issue. The staff would conduct the workshop and report its findings back to the Commission within five months of the Commission's decision. The staff would also continue to perform tests to establish the small open flame and cigarette ignition resistance of FR fabrics or other appropriate safety technologies, to establish the extent of potential benefits associated with a standard that reduces the cigarette ignition propensity of upholstered furniture.

With respect to the pending portion of the NASFM petition on cigarette ignition, the staff recommends that the Commission defer action until it decides whether to propose a small open flame rule that may have substantial cigarette ignition benefits. This course would provide the Commission the flexibility of proceeding separately on cigarette ignition if it determines that regulatory action may be necessary to address that risk.

Attachments

TAB A: Petition FP 93-1 (with supporting correspondence), F. McGarry, National Association of State Fire Marshals, April 14 & May 20, 1993, and January 4, 1994.

Consumer Product Safety Commission, Advance Notice of Proposed Rulemaking, Federal Register, June 15, 1994.

TAB B: Staff memorandum, National Fire Estimates for Smoking Material Ignited Upholstered Furniture Fires, K. Long, EHHA, to D. Ray, September 16, 1997.

Staff report, "Small Open Flame Ignitions of Upholstered Furniture: Final Report," K. Long, EHHA, to D. Ray, September 16, 1997.

TAB C: Staff report, "Upholstered Furniture Flammability Testing: Full Scale Open Flame Data Analysis," L. Fansler et al, LSE, February 26, 1996.

Staff memorandum, Match Burn Times, J. Murphy & R. Khanna, ESME, to Files, November 9, 1995.

TAB D: Staff memorandum, Summary of Upholstered Furniture Tests, with attachments (12 LS staff memoranda), L. Fansler, LSE, to D. Ray, September 19, 1997.

TAB E: Staff memorandum, Analysis of Preliminary Interlaboratory Study, with attached test method, J. Murphy, ESME, to D. Ray, April 30, 1997.

Staff memorandum, European Test Data, Open Flame and Cigarette Ignition of Upholstered Furniture, J. Hoebel, ES, to D. Ray, May 28, 1997.

TAB F: Staff memorandum, Toxicity of Flame Retardant Chemicals (FR's) used in Upholstery Fabrics and the Toxicity of Smoke from FR-treated Fabrics, L. Mishra & M. Wind, EHHS, to D. Ray, September 12, 1997.

Letters from H. Matthews, NIEHS/NTP (August 22, 1997) and A. Chaturvedi, FAA/CAMI (August 15, 1997) to M. Wind, EHHS re: FR chemical toxicity review.

TAB G: Draft Standard for Small Open Flame Ignition Resistance of Upholstered Furniture, R. Khanna, ESME, October 1997.

Technical Basis Report for the Draft Performance Standard for the Flammability of Upholstered Furniture, R. Khanna, October 3, 1997.

Staff memorandum, Comparative Heat Flux and Temperature Measurements for Various Open Flame Sources, J. Murphy, ESME & L. Mulligan, LSE, to D. Ray, June 17, 1997.

Draft CPSC Furniture Flammability Fixture Operation Manual, M. Eilbert, LSE, June 1997.

TAB H: Staff report, "Economic Considerations of Regulatory Options for Addressing Small Open Flame Ignitions of Upholstered Furniture Flammability," C. Smith, ECPA, September 1997.

Tab I: Letters from J. Ziolkowski, American Furniture Manufacturers Association, to D. Ray, March 3, 1995, and January 12, 1994.

Letters from T. Fritz, ASTM, to D. Ray, December 26, 1996, K. Reimann, ASTM, to D. Ray, May 9, 1997, and J. Thomas, ASTM, to D. Ray, July 2, 1997 (with attachments).

TAB J: Staff memoranda (six), Analysis of ANPR Comments on Upholstered Furniture, K. Long, EHHA, L. Fansler & J. Murphy, LSE, R. Khanna, ESME, C. Smith, ECPA, M. Babich, EHHS, and T. Smith, ESHF, April & May, 1997.

TAB K: Staff report, "Cigarette Ignition Propensity of Upholstered Furniture" (with attachments), C. Smith, EC & L. Fansler, LSE, November 1996.

TAB L: Staff memorandum, Economic Considerations for Upholstered Furniture Petition FP 93-1, C. Smith, EC, to D. Ray, November 15, 1996.